Rocky Flats Citizens Advisory Board
Transition Work Plan
2004 Through Site Closure

Approved October 2003

Executive Summary

The U.S. Department of Energy's recently published policy on public participation and community relations states, "Effective public participation is at the core of good community relations, which is essential for DOE facilities to achieve their missions." The Rocky Flats Citizens Advisory Board (Board), established in 1993, enables concerned citizens to gain information and understanding about the work being planned or performed at the Rocky Flats Closure Project. The Board facilitates the gathering of diverse opinions and perspectives from communities within the vicinity of Rocky Flats, thereby assisting the Department in making more informed decisions on cleanup and closure activities.

The Board's mission is:

> The Rocky Flats Citizens Advisory Board, a nonpartisan, broadly representative, independent advisory board with concerns related to Rocky Flats activities, is dedicated to providing informed recommendations and advice to the agencies (Department of Energy, Colorado Department of Public Health and Environment, and the Environmental Protection Agency), government entities and other interested parties on policy and technical issues related to cleanup, waste management, stewardship and associated activities. The Board is dedicated to public involvement, awareness, and education on Rocky Flats issues.

As Rocky Flats transitions its work and workforce for closure, so must the Board. The purpose of this plan is to identify and discuss the work being performed by the Board, the resources needed to perform that work, and how the Board can continue to support the Department's closure mission, as well as with its post-closure and long-term stewardship responsibilities. As closure is nearing completion, post-closure and long-term stewardship activities are being identified, defined, and planned. The Board can play a vital role in assisting the Department with these activities as it has in the past with cleanup and closure activities. Gaining public understanding and acceptance of the work to be or being performed can build mutual understanding and trust. The history of the Board, its interaction with local communities and public interest groups, and the successful partnership with DOE and federal and state regulators; distinguishes the Board's ability to achieve its mission of providing policy and technical recommendations with public involvement, awareness, and education.

Introduction

In the early 1990s, the U.S. Department of Energy (DOE) created Site Specific Advisory Boards at current and former nuclear weapons complex sites chartered under the Federal Advisory Committee Act of 1972. The purpose of the Department's Boards was to improve public involvement in cleanup decisions at the sites. There are currently nine Boards in existence across the country.

The Rocky Flats Citizens Advisory Board (Board) was established in 1993 and enabled concerned citizens to gain information and understanding about the work performed at Rocky Flats from a variety of sources including Board and staff members, DOE, and Federal and State regulators. The Board serves two primary purposes -- providing policy and technical comments and recommendations as well as engaging the public and the DOE in open dialogue. Now in its eleventh year, 80 individuals have served as Board and staff members. Currently, 12 Board members with diverse backgrounds and opinions represent citizens, communities, and organizations in the vicinity of the Rocky Flats Closure Project site and supported by two staff members.

The Rocky Flats Closure Project was designated as an accelerated closure pilot project by the Secretary of Energy in 1997, and supported by Congress through special closure project funding. The Secretary chose the site for several reasons. Chief among them was that Rocky Flats was the largest former nuclear weapons production facility positioned for accelerated closure. The project is currently ahead of schedule and actual closure is expected to be months earlier than the planned closure date of December 15, 2006, thereby saving the federal government, and ultimately the taxpayers, millions of dollars.

The Board has played a significant role in providing policy and technical recommendations on cleanup and closure activities to the Department. The Board operates under a consensus decision-making process. The value to this process is that all opinions are voiced, considered, dispositioned, and/or reconciled prior to recommendations being forwarded to the Department and its closure contractor, Kaiser-Hill. Some key examples of these recommendations are:

- Community Involvement in Rocky Flats Cleanup Plans: With involvement from citizens in the area surrounding Rocky Flats, the Board produced a list of Community Values. Some of the values were incorporated into the original version of Rocky Flats Cleanup Agreement. The Board also wrote a white paper entitled, "Plutonium at Rocky Flats: A Framework for Decision-Making" outlining community views on the safe storage and ultimate disposition of plutonium. In 1999, the Board developed and published the "Vision for Cleanup at Rocky Flats." Numerous points expressed in this document were incorporated into the cleanup plans for the site. These efforts enabled the Board to involve the broader community in developing the materials and later served as education and outreach tools to local communities.

- Funding and Priorities for Cleanup at Rocky Flats: The Board, along with the Colorado Department of Public Health and Environment and the U.S. Environmental Protection Agency, recommended that the site delay some environmental restoration projects in areas of less risk so that funding could be applied to areas of greater risk. Ultimately, $31 million

was shifted toward the more critical projects resulting in more rapid risk reduction. The Board proposed mortgage reduction activities for buildings that had no future site purpose. Those funds were then applied to accelerated cleanup activities. Another recommendation was to accelerate the consolidation of plutonium into one or two facilities so that the vacated facilities could be turned over to the mortgage reduction program. These activities eventually became the centerpiece of the closure project that had support from the communities.

- Independent Review of the Soil Action Levels: The Board and representatives from local governments recommended that the Department fund an independent assessment of the soil action levels due to an uproar from citizens that the levels were too high. The Board served as the contract manager for the assessment. The assessment resulted in greater understanding by the community on the science behind determining action levels and the communities had less apprehension about the science when the Department and its regulators recently proposed the revised action levels.

- Independent Review of Environmental Monitoring: The Board contracted for an independent review of environmental monitoring activities at the site. The review raised awareness that environmental monitoring was an important issue for the community. This led to greater involvement by the community in ongoing site activities such as the Integrated Monitoring Plan.

- Comments and Recommendations Related to the Actinide Migration Evaluation: The Board contracted with two experts to review and comment on work products of the Actinide Migration Evaluation (AME). The Board formed a Technical Review Group to closely follow the AME studies and work with the experts. The experts served as an independent, credible resource that provided greater community confidence in the work of the AME. Many of the comments and suggestions were incorporated into the AME.

Work Scope Focus Areas

The Board is organized as a non-profit organization that is funded annually through a grant from the DOE. Emphasis is placed on independent technical review and assistance as well as independent control of staff and operations. Annual work plans identify areas of focus to be addressed by the Board. The work is performed through committees comprised of Board members. Community members with technical expertise are also available to the Board. When deemed necessary, the Board contracts out for subject matter experts to perform independent peer reviews to provide the Board with impartial and credible technical feedback. These independent peer reviews have increased the credibility and confidence of the work being performed.

Each year, the Board requests input from the DOE, the Colorado Department of Public Health and Environment, and the U.S. Fish and Wildlife Service on what activities the agencies would like Board involvement. The results of this year's request are reflected on Attachment A.

An important function for the Board is document review. The Board reviews and comments on reports or other written material associated with the closure project that are of interest to

surrounding communities as well as the Board. Recommendations on these various reports and documents are provided to the Department.

Cleanup and closure progress is monitored by the Board on a routine and continuous basis. Updates are provided at monthly board and committee meetings. Representatives of the Board participate in meetings sponsored by the site. Ongoing environmental monitoring activities continue to be an important issue for the communities. The Board's oversight of these activities provides a greater knowledge and involvement from the public.

Specific focus areas of work currently planned are as follows:

Outreach and Education: Community outreach and public education is an important part of the Board's role. The Board maintains a website providing information about the Board's activities and the cleanup activities at Rocky Flats. The website contains all Board recommendations, upcoming meeting dates and agendas, membership information, background material, and links to other related websites. The website also provides a direct link where users can send messages to Board members. Opinion polls on issues of concern may also be conducted via the website. The Board publishes periodic newsletters with a mailing list of over 3,500 individuals and organizations. Board members provide briefings and information to community groups as requested. Some specific areas for increased focus include the following:

- Community Outreach Workshops: The Board plans on conducting annual workshops to actively seek the views of concerned citizens and surrounding communities. The workshops will serve as the catalyst to both inform and educate the public on closure activities at the site.

- Countdown to Closure: The Board's communications with concerned citizens and communities will focus on imminent closure. With the project closure ahead of schedule, the outreach activities need to reflect the current status as well as to inform the public on post-closure and long-term stewardship issues and activities. The newsletters will reflect this new communications style and message.

- Site-Specific Advisory Board (SSAB) Chairs Meetings: The Board will continue active participation and support of the SSAB Chairs Meetings sponsored by the DOE. The meetings provide opportunities for the SSAB Chairs to understand and be involved in complex-wide issues facing the DOE and local communities at each of the cleanup sites. Success stories, lessons learned, and programmatic interrelationships between sites are presented and discussed at the meetings, thereby providing the Chairs with the larger strategic picture of the cleanup activities. The Rocky Flats Board has been recognized by the Department as a model for how SSABs should operate and be involved with the Department's mission accomplishments.

- Student Workshops: These workshops will enable "the next generation" to become knowledgeable on and involved in the cleanup and closure work being conducted at the site. The Board will partner with local colleges and universities, as well as other learning institutions, to work with students who are in scientific and environmental studies. The benefit to the Board will be to provide a knowledge foundation for long-term stewardship

and legacy issues and the benefit to the student will be "hands on" knowledge in their field of study.

D&D: A cleanup goal at Rocky Flats is to remove all buildings and facilities from the site. The decontamination and demolition (D&D) of the buildings is of major interest to the Board and surrounding communities. The Board provides recommendations on D&D activities. As D&D progresses past the planning stages, the Board tracks the progress of activities, weighing in on issues that might be of concern, and conducting independent peer reviews when necessary. Some specific areas of interest include the following:

- Building 371 Decommissioning Operations Plan (DOP) Modification: Building 371 is one of the major former plutonium production facilities. The plan describes in detail the D&D activities for Building 371. The Board will review the document, provide comments and recommendations, and track completion of the D&D work.

- Building Foundations: The foundations of many of the former weapons production buildings is the interface between where D&D work stops and environmental restoration work begins. Decisions on what remains and what is cleaned up with respect to these foundations is of major community concern and interest to the Board.

- Independent Validation and Verification: The Board strongly advocates independent validation and verification of the sampling methods and results to provide credibility to the sampling process.

- Orphan Waste: Cleanup work at Rocky Flats results in the generation of waste materials. Most of these materials are shipped off-site as low-level waste to disposal sites in Utah and Nevada. A smaller portion of the waste, which is transuranic waste, is shipped to the Waste Isolation Pilot Plant in New Mexico. There are some waste streams that currently do not have a disposal site identified. These orphan wastes could create a problem of timely closure if an off-site repository is not found and wastes need to be stored on-site beyond the closure date. The Board will track the development of disposition pathways for these orphan wastes.

Environmental Restoration: Environmental restoration is of great interest to the communities and the Board. To better understand issues, the Board conducts independent research and, at times, contracts for independent peer reviews. As remediation plans are implemented, the Board tracks progress on the activities, providing comments and recommendations where appropriate. Areas of particular interest related to environmental restoration include the following:

- Final Site Configuration: The Land Configuration Design will specify the basis for the final contouring of the industrial area. In order to control storm water runoff and erosion problems, drainage areas may need to be re-contoured. Public input on the design and integration with specific environmental restoration and D&D projects will be solicited by the site on this activity.

- Industrial Area Groundwater: Plans to address the cleanup of contaminated groundwater in the Industrial Area will be released in late 2003. The Board will review the plans and provide comments and recommendations. Cleanup work will be monitored.

- Landfills: There are two major landfills at Rocky Flats, the Original Landfill and the Present Landfill. The remediation plan for the Present Landfill was released in September 2003 calling for the construction of a geosynthetic cover over the area to protect against future water infiltration. Plans for the Original Landfill will be released later in 2003. The Board will track implementation and project completion.

- Near-Term Stewardship Activities: For each accelerated remedial action, the site will have near-term stewardship obligations through closure. Examples of these activities include revegetation, access controls, and remedy performance monitoring. The information on these activities needs to be transferred to the Corrective Action Decision/Record of Decision, one of the final documents describing all the cleanup work that has taken place and whether any further unacceptable risks to human health or the environment remain, and a post-closure information management system. The Board will track the progress and activities to ensure that all obligations are met.

- Original Process Waste Line Characterization: The site will begin borehole drilling along known and suspected waste line leaks in accordance with RFCA Attachment 14. The site's implementation of this sampling protocol, as well as the extent of soil contamination originating from the waste line leaks, will be of interest to the Board.

- Other Groundwater Treatment Units: Several groundwater treatment activities are currently on-going. The Board will continue to track progress, and provide further comments and recommendations as necessary.

- 903 Pad and Lip Area: The 903 Pad, a former contaminated drum storage area, led to most of the plutonium soil contamination due to drum leakage. The pad itself is currently undergoing active remediation. Work will commence in 2004 to address the area surrounding the pad, known as the lip area or americium zone. The Board will track and monitor completion of the pad remediation and will provide comments and recommendations on the lip area cleanup plan. The Board will continue to track progress and provide additional comments or recommendations if necessary.

- Surface Water Management/Terminal Ponds and Sediments: Several streams originate on Rocky Flats property that may carry contamination off-site. Sediments in some of these streams are contaminated. Diversion ponds have been built along these streams to protect against off-site contaminant releases. How the sediments and ponds are cleaned up and how the ponds, particularly the end or terminal ponds, will be maintained in the future are of particular interest to the Board and the downstream communities. The Board will provide comments and recommendations on the cleanup plans. Oversight, once the actual cleanup work begins, will be performed.

Site Transition Activities: Rocky Flats will become a National Wildlife Refuge when cleanup is complete and the site is closed. Planning activities for the refuge are underway. The Board will conduct research on issues or topics, perform document review and comment, contract for

independent peer reviews when warranted, and conduct oversight activities. Specific issues of concern on refuge activities include:

- Comprehensive Conservation Plan (CCP): U.S. Fish and Wildlife is currently developing the CCP, a master plan that describes what activities will take place at the future refuge. The Board has tracked the development of this plan scheduled for release in draft form in early 2004. The Board will review and comment on the plan and track implementation.

- Environmental Impact Statement (EIS): The EIS is being developed simultaneously with the CCP as required by NEPA regulations. Once released in draft form, the Board will review and comment on the EIS. Recommendations will be provided to DOE.

- Memorandum of Understanding (MOU): The MOU between DOE and U.S. Fish and Wildlife Service will define the roles and responsibilities of the agencies with respect to planning for and ultimately managing the refuge. It is anticipated that the MOU will be available by the end of 2003. The Board will review and comment on the MOU, and provide careful oversight of its implementation.

Stewardship Activities: Because Rocky Flats will have residual contamination after closure, the Board is concerned that a comprehensive and enforceable long-term stewardship program be established. Planning for stewardship is ongoing and will continue through the post-closure period. There are various topics the Board will investigate and research. Independent peer reviews may be deemed necessary by the Board. Implementation of stewardship activities will require oversight by the Board. Items of particular interest include the following:

- Corrective Action Decision/Record of Decision (CAD/ROD): One of the final documents produced when cleanup is complete is the CAD/ROD. Determinations on whether all the risks have been addressed will be of great interest to the communities. The Board will closely follow the development of the CAD/ROD and provide comments and recommendations when the document is released for public comment.

- Long-term Stewardship Strategy/Plan: The Department is currently preparing the strategy document that will continue to evolve as closure progress is made. The Board will review and comment on the document. As the stewardship strategy becomes an actual plan, the Board in very interested in how the plan will be enforced. The Board will provide comments and recommendation in the development of a comprehensive and enforceable stewardship plan.

- Remedial Investigation/Feasibility Study (RI/FS): As part of the documentation process to declare the end of cleanup work, the site will prepare the RI/FS. An important part of the RI/FS will be the Comprehensive Risk Assessment (CRA). The purpose of the assessment is to document the risks from residual contamination at the end of site remediation activities. Residual risks to both human and ecological receptors and the ecological monitoring performed to support the assessment are likely to be of great concern to communities. Planning for the CRA will take place in FY 2004 with the final document released in FY 2005.

Board Closure Plan and Activities

The Board will publish a final report to the community outlining the major work of the Board since its inception. The report will document the Board's contribution to accelerated cleanup and closure of the site and outline lessons learned from the Board's perspective. Final recommendations from the Board to the DOE will be included in the final report, along with a discussion about the necessity and scope of work for future public participation efforts related to the post-closure and long-term stewardship activities.

Legacy Management Site Specific Advisory Board

In keeping with the Department's policy on public participation and community relations, the newly established Legacy Management (LM) organization may determine that Site Specific Advisory Boards, similar to the Environmental Management (EM) boards, will facilitate the gathering of diverse opinions and perspectives from surrounding communities and concerned citizens. These boards could assist LM early in the decision-making process to determine the best course of action, prioritization of activities, and provide mutual understanding and trust between LM and the public. The existing Board could assist with the transition of programmatic responsibility as LM receives post-closure and long-term stewardship upon successful closure completion.

Activities that a board could concentrate their efforts on may include the following:

- Quarterly Reviews: A board could conduct quarterly reviews of the surveillance and maintenance work being performed at the closure site. Verification and validation could be accomplished through independent peer reviews.

- Cleanup and Closure Records and Information: A board could assist LM with keeping the public informed about the history of the site, site closure activities, and work being performed at the closed site to ensure public health and safety and protection of the environment. A board could direct interested concerned citizens to the appropriate information and documentation that addresses their issues and concerns.

- Community Outreach: A board could provide similar services to the LM program as was provided to EM. Aiding LM in gaining the public's confidence and trust of work being performed at the closed site and priorities of that work could enable the organization to achieve its mission.

The Board looks forward to having an open dialogue with the LM leadership on the benefits of site-specific advisory boards and, specifically, how the RFCAB members could be beneficial to the LM program.

Attachment A
Summary of Recommended Priorities for RFCAB by Agency

		Agency Priority		
Project/Topic	**Timeframe**	**DOE**	**CDPHE**	**FWS**
Final Regulatory Closure of Site (RI/FS, etc)	Now through closure	X	X	
Long-Term Stewardship	Now through closure	X	X	
Present Landfill IM/IRA	Sep / Oct 2003	X	X	
Original Landfill IM/IRA	November 2003	X	X	
903 Lip Area IM/IRA	Oct / Nov 2003	X	X	
Groundwater IM/IRA	Early 2004	X		
Land Configuration Design	Through 2004	X		
Surface Water Management	No specific timeframe given	X		
Original Process Waste Line Characterization	Begin late summer / early fall 2003		X	
B771 Demolition	June 2004		X	
B776 Demolition	Begin late summer to early fall 2004		X	
Draft Comprehensive Conservation Plan / EIS	Jan / Feb 2004			X

APPENDIX A

DESCRIPTION OF STEWARDSHIP CONTROLS

Physical and Institutional Stewardship Controls

The toolbox defined processes for determining appropriate considerations associated with long-term remedies. This appendix provides additional detail and discussion about those considerations. Over time, additional knowledge will be gained that may change some of this discussion.

These considerations are grouped by physical controls and institutional controls. Within each section and as available, the discussion covers a description, technical aspects, public acceptance, whether the item was included in the Rocky Flats Stewardship Cost Estimate provided to Congress in 2000, advantages and disadvantages, and case study information. Sections not considered applicable to Rocky Flats are also noted. Items addressed are as follows:

Physical Controls
I. Caps, Covers, and Liners
II. Subsurface Barriers
III. Access Deterents
IV. Ponds and Ditches

Institutional Controls
I. Governmental Controls
II. Proprietary Controls
III. Enforcement Tools
IV. Informational Devices
V. Planning Systems

The research compiled in Appendix A was conducted and written by John McCartney (CDPHE). Although the research in Appendix A was commissioned by the Stewardship Working Group, it has not been subjected to any Stewardship Working Group review and therefore does not necessarily reflect the views of the Working Group, and no official endorsement should be inferred. We provide it because we believe it adds important value to any stewardship dialogue.

References cited in Appendix A can be found in Appendix C, the Long-Term Stewardship Bibliography.

Physical Controls

Physical controls are the primary barriers to limit unauthorized access to contaminants and to limit exposure to hazards that exist on the site after remediation is complete. These controls "physically" reside at the site of or in near proximity to the actual contamination, and may include containment structures such as caps (also referred to as engineered controls), and access barriers such as fences.

I. Caps, Covers, and Liners

A. Soils

1. Materials

- Different soil types have different strength and hydraulic behaviors. Soil is composed of solid particles which do not fit together in a completely contiguous mass. The spaces between particles, called pores, may be filled with liquid (water, leachate, oil) and/or gas (air, landfill emissions). This combination of three phases causes the soil to act as a unique material.
- Sand and gravel are made from large particles (two millimeters to several centimeters in diameter), and rely on gravity to hold the soil mass together. Water is able to flow through the pore spaces very easily. The large sizes of the particles imply that shear forces may be resisted by both the roughness of the particles and their interlocking geometry. Sand (and all other soils) does not have any tensile strength.
- Clays, which consist of much finer particles, behave in a plastic manner because there is adhesion between the particles. Clays are the end product of weathering processes, thus individual solid particles are often smaller than 2 micrometers (colloid size). A unique property of clay minerals is their electrically negative charge. The particles attract positively charged material, which is often found in electrolyte rich groundwater. Films of water form over the clay particles, creating an adhesive mass. Because of these tightly bonded particles, water flow is impeded through the clay matrix, resulting in a much lower hydraulic conductivity than larger grained soils. Clays do not have a very high shear strength compared to sands and gravels.

2. Applications

- Clay is often used as a hydraulic barrier because of its ability to restrict the flow of water from one area to another. Water will still pass through the soil, but the rate and volume of the water flow are insignificant. These hydraulic barriers used in landfill applications are often called Compacted Clay Liners (CCL). A unique property of compacted clay is that the soil will "shrink" as water is removed by evaporation, causing the soil to crack. This is a limitation of using CCLs in arid regions.
- Sand is often used as engineering backfill because of its high shear strength. Sand has also been used as a drainage layer, because water may flow laterally through the soil with little impedence.

B. Geosynthetics

1. Materials

- The use of geosynthetics, including continuous, woven, or non-woven synthetic polymers in cap-liner systems, is a relatively new technology.

2. Types and Applications
   - Geomembranes act as hydraulic barriers, geotextiles act as filters, protection layers and soil enforcements; geonets act as drainage layers; geogrids act as soil reinforcements; geosynthetic clay liners (GCLs) act as a composite soil-geosynthetic hydraulic barrier; geocells act as erosion controls; wick drains act as vertical drains; and geopipes act as drainage conduits. There are several other types and applications of geosynthetics being investigated, and their presence is an asset to geotechnical and geoenvironmental design.
   - Although many of these applications (hydraulic barrier, protection layers, drains) may be accomplished using soil materials, geosynthetics tend to be more consistent in their properties and expected performance and more readily available than specific soils like clay, and require less vertical space in a landfill allowing more waste to be contained. However, geosynthetics may be more costly and prove to be more difficult to place properly in the field than soils used for these applications.
   - In landfills, the main uses of geosynthetics are for hydraulic barriers, drainage layers, protection layers, reinforcements and erosion controls. Hydraulic barriers limit the flow of liquid into and out of the landfill, where hazardous materials generated from the waste must be isolated. Drainage layers allow any liquid generated by or passed through the waste to be collected, or may act as leakage detection layers. Protection layers protect other geosynthetics from sharp or heavy objects that may be present in a landfill, increasing the puncture resistance and bearing capacity. Reinforcement layers provide tensile strength to a cover or liner, resisting slope failures and allowing covers to function under differential settlement of the underlying waste. Erosion layers provide a lasting stabilization to surface soils that would otherwise be eroded by surface water flow or wind.
   - The performance of a specific geosynthetic may be susceptible to chemical, biological and UV degradation, construction damage, and time dependent stress-strain behavior. For this reason, geosynthetics used in a landfill design must be made from polymers or configurations selected to resist the (expected) chemical and biological composition of the contained waste or leachate and should not be left in direct sunlight. Placement in the field should be done with adequate quality control and quality assurance.
   - Geosynthetics can be used for a wide range of functions in a cap system, such as horizontal or vertical barriers for limiting seepage into the contaminated waste, filters, leachate drains, soil reinforcement and erosion control of soil above the waste.

C. RCRA Subtitle D and C Cap-Liner Systems

1. RCRA Subtitle D
   - This regulation applies to new municipal solid waste (MSW) landfills.
   - The regulations provide sighting resistance for the landfills which include proximity limits to airports, floodplains, seismic zones, wetlands, and unstable

areas. In addition, the regulations provide minimum design criteria for MSW landfills and require long-term financial obligations from the landfill owner.

- Landfill owners are required to monitor the landfill's hydraulic performance at at least one point of compliance for 30 years following closure. The owner must also prove that he is financially able to cover the costs of a landfill failure throughout the life of the landfill.
- Liner Design: Composite liner with a CCL (hydraulic conductivity greater than 10^{-7} cm/s) at least 0.6 meters deep, overlain by a geomembrane which is overlain by a soil/geosynthetic protection and drainage layer.
- Cover/Closure Design: CCL (hydraulic conductivity greater than 10^{-5} cm/s) or material with equivalent hydraulic performance of the liner. This is a contested requirement, and typically depends on the state's approval of the cover. The CCL is covered by an erosion protection layer with vegetation.

2. RCRA Subtitle C
   - This regulation supplies prescribed designs for new hazardous waste (HW) landfills. The information included is similar to RCRA Subtitle D, except for the landfill design requirements, which are stricter.
   - The same long-term requirements are made for the landfill owner, but monitoring requirements and financial obligations may be greater, depending on the situation.
   - Liner Design: Double composite liner with each layer being similar to the single composite layer required by RCRA Subtitle D.
   - Cover/Closure Design: Composite CCL and HDPE equivalent to the RCRA Subtitle D liner system. This is typically overlain by an erosion protection layer and vegetation.
3. Technical Aspects
   - RCRA C and D caps are designed to function for 1000 years, but a conservative estimate of their lifetime is 200 years [181, pg. 13].
   - When these caps are used for hazardous material, they must be designed according to the guidelines set forth by RCRA Subtitle C, or prove that they are equivalent [107, pg. 27].
4. Public Acceptance
   - The Rocky Flats Citizens Advisory Board (CAB) believes that low-level waste containment systems such as cap-liner systems are not acceptable long-term solutions. If used, the CAB suggests monitoring these systems every five years and replacing or refurbishing the system after 200 years [105, pg. 9].
   - Covers can have many different aesthetically pleasing finishes, making them a good solution for a "natural" look in a wildlife refuge.
   - The use of caps, barriers or pumping in containment systems to prevent additional migration of contaminants may achieve design criteria, but they also imply a need for monitoring, maintenance, repair and replacement activities. All of these factors contribute to the life-cycle cost of a system, so they should be appropriately weighed in comparing remedies and long-term physical containment [205, pg. 6].
5. Rocky Flats Stewardship Cost Estimate

- The cost estimate assumes that RCRA type caps will be used at five disposal sites totaling 90 acres on the site. The Rocky Flats Cost Estimate does not identify the original cost of a RCRA type double lined HDPE barrier system as a stewardship cost, but as a cleanup cost. DOE assumes that there will be no maintenance or replacement of any barrier systems within the next 70 years, but annual erosion repair is estimated to be about $17,000 total for the five systems. There will also be noxious weed control in the disposal cells equal to about $37,000 per year total for the five cells.
- It is important to note that the National Defense Authorization Act (NDAA) submittal says that non-RCRA evapotranspiration caps will be used at Rocky Flats, while the cost estimate assumes RCRA type covers. This discrepancy may be due to older policies at the time of the cost estimate.

D. Evapotranspiration (ET) Alternative Covers

1. Technical Aspects

- These waste cover systems are useful in arid climates where the potential evaporation combined with the movement of water through plants (evapotranspiration) greatly exceeds the annual precipitation. They function by taking advantage of a natural water balance – water infiltrates from the surface from precipitation or melting snow, and is then stored in the soil until it evaporates from the surface or transpires through the vegetative cover.
- The goal is of an ET cover is to avoid water percolation into the underlying waste. In addition, an increased amount of water storage in the soil layer from growing year to growing year should be avoided, but storage should never be so low as to cause wilting of the vegetative cover.
- Evaporation is the dominant water removal process in the top few centimeters of the soil cover, while transpiration via root uptake is the dominant water process throughout the remainder of the soil profile.
- These barriers use loam, a loose silty soil, combined with natural grasses and forbs. The plant roots must be able to drain a section of soil about two meters deep, but must not grow so deeply as to infiltrate the underlying waste. A layer of dense gravel placed beneath the loose soil serves to protect the underlying waste from plant root and burrowing animal infiltration [153; 152].
- Surface cracking, animal infiltration and local settlement of the loose soil has been shown to be a problem, but has only been seen to be a superficial problem, with no significant effect on the water balance of the ET cover. The silt-loam soil has less volumetric change (than clay soils) when water is removed from the soil matrix, so less cracking is apparent in arid climates. It is anticipated that cracking in silt-loam soils will be self-healed when water enters the soil and that extensive vegetation will help limit cracking [152].
- Depending on the thickness and permeability of the silt-loam cover, ET barriers can also effectively control radon gas emissions (*Id.*).

2. Public Acceptance

- These covers are not included in the prescriptive covers listed in Subtitle C of RCRA, but they are acceptable if they can be shown to be "RCRA Equivalent". In other words, equivalent percolation performance must be

demonstrated by comparative analysis, and a field test must be conducted [152].

3. Rocky Flats Stewardship Cost Estimate
   - It is assumed that ET covers will be used as caps at Rocky Flats but they are not currently included in the stewardship cost estimate. The ET cover will likely require less initial funding than RCRA Subtitle C prescriptive covers as they have lower potential material, construction and quality control costs. Nevertheless, costs due to regulatory compliance should not be ignored. Long-term costs of ET covers are believed to be significant.
4. Case Studies
   - ET covers were being tested at the Rocky Mountain Arsenal site for regulatory compliance (September 2000-September 2001). There are four test plots, each with different initial soil compaction characteristics and soil depths. Beneath the soil, a lysimeter collects all of the percolated water that passes through the soil barrier without being evaporated or absorbed by the vegetative cover (*Id.*).
   - Idaho National Engineering and Environmental Laboratories has been conducting studies for the past fifteen years on the proper plant cover to be used in ET covers to ensure proper water balance. The plant species are evaluated on transpiration properties throughout the growing season (via leaf-area index analysis), ability to withstand drought, ability to form diverse and stable stands, and resilience to weed infiltration and wildlife foraging.
   - Vegetation control is essential, the importance of which can be learned from the Burrell, Pennsylvania uranium mill tailings disposal cell. Plant roots and their effect on soil particle arrangement has increased the cell's hydraulic conductivity from the regulatory level of 10^{-7} cm/s to 10^{-5} cm/s, which is not sufficient to control groundwater flow according to RCRA Subtitle C. Control with herbicides and other chemicals may not be the best solution though, as these are usually hazardous themselves and may seep into the groundwater [147, pg. 5].

E. Other Alternative Cover Systems

1. Capillary barriers
   - Capillary barriers use the soil mechanics concepts of capillary suction and unsaturated flow to prevent water from percolating into a waste layer. These covers typically perform very well in arid climates, but do not perform well in areas where snow banks form on the ground or where there is a large amount of precipitation.
2. Geosynthetic clay liner barriers
   - Geosynthetic clay liner barriers provide several advantages over compacted clay liners such as ease in placement, less cracking potential due to volumetric shrinkage and freeze-thaw cycles and lower product costs if there is not a local clay to use in a CCL. The main disadvantage of GCLs is the specific clay used in the product is known to have the lowest shear strength of all clays.

3. Case Studies for Cap/Liner Systems
    - In early 1995, CSX Railroad began an expansion project for their rail lines, which are located near the Canal Ridge Road/Mullins toxic dump site near Cincinnati, Ohio. The city of Cincinnati informed CSX Railroad about the presence of the toxic dump located near the rail line in late 1994. The company conducted numerous soil borings, and reported both strong petroleum odors and liquid sludge, but still believed that they were not working on the dump site. Excavation commenced, and metal drums containing chromium, lead and vinyl chloride were encountered. In July of 1995, the Ohio Environmental Protection Agency made five investigations of the site, and ordered CSX to collect and contain waste-laden water leaking out of the excavation. The company complied, but not until October, during which time the water was leaking into a nearby sewer inlet. The contractor for CSX claimed that it obtained all permits thought to be needed. Construction stopped and limited contaminant migration controls were put in place, but the immediate health hazard had not been identified at the time of the article, as there were no human receptors living near the site [50, pg. 1-2].
    - The existence of institutional controls may greatly change the effectiveness of a designed cap/liner system. At the Industri-Plex site in Woburn, Massachusetts, the institutional controls being developed by the EPA and the Primary Responsible Parties are performance standards intended to guide the way in which operators and owners are permitted to breach and restore the cap. These controls were put in place to ensure that industrial reuse of the high-value property is not limited by the existence of residual contamination. Many local commentators have criticized this institutional control plan as it is not directly linked with the remedy, which may hinder the remedy's effectiveness to provide adequate protection for human health and the environment [90, pg. 55].

II. Subsurface Barriers

A. Slurry Walls

1. Technical Aspects
    - A slurry wall is a vertical barrier of bentonite clay and soil that prevents the horizontal flow of groundwater [107, pg. 27].
    - Permeability tests are required to ensure the contaminated groundwater will not dissolve the bentonite and adversely affect the quality of the barrier (*Id.*).
    - These barriers may also help by diverting uncontaminated water away from the contaminant source [70, pg. 35].
2. Public Acceptance
    - These controls have been used for many years, and are quick and functional. The cost depends on the depth of the barrier, the equipment required, and any admixtures added to enhance the properties of the barrier (*Id.*).
3. Rocky Flats Stewardship Cost Estimate
    - DOE did not include slurry walls as a component in the control of groundwater flow at the Rocky Flats.

B. Permeable Reactive Barriers (PRBs) and Passive Treatment Walls

1. Technical Aspects
   - These barriers are both a long-term remedy, passively treating contaminated groundwater, and a physical control, containing the contaminated groundwater to a certain known area.
   - PRBs rely on a chemical slurry barrier that is permeable to normal groundwater, but not to specific contaminants such as volatile organic compounds. Adhesive forces between the chemicals in the slurry and the contaminants stop contaminant movement. The contaminants can then be removed, and the reactive chemicals can be reused [181, pg. 7].
   - This solution will stop only selected water-soluble contaminants, but will not stop all possible sources of groundwater contamination (*Id.*). Continuous monitoring is necessary to ensure proper functioning.
2. Public Acceptance
   - The cost of these systems is one-fourth that of pump and treat systems because of the lower amount of maintenance required (*Id.*). Because the effectiveness in treatment and containment of wastes by both this system and pump and treat systems is unknown, communities may favor passive treatment walls solely because of their lower costs.
3. Rocky Flats Stewardship Cost Estimate
   - The three passive barrier walls at Rocky Flats make up a significant portion of the stewardship cost estimate for physical controls. The systems require replacement of the iron filings (used as the reactive chemical) every ten years. The replacement cost for each wall is $67,200 per wall, or $201,600 to replace all of the walls, and the replacement time is about one week per wall. While the new filings only cost $40 per cubic yard, the disposal cost of the used filings (which are considered low level wastes) will be about $3,000 per cubic yard. Each load of used filings must be sampled to ensure there are no higher-level wastes.

III. Access Deterrents

A. Fences

1. Technical Aspects
   - Fences and walls provide a warning to the presence of a restricted area, and prevent accidental access to the area [107, pg. 28].
2. Public Acceptance
   - Fences may be considered a stigma to the community.
   - Fences might not be publicly accepted in a natural setting, but may be accepted in an industrial area (*Id.*).
3. Rocky Flats Stewardship Cost Estimate
   - For the perimeter of the site, a four-strand wire fence is believed to provide adequate warning and protection. The bottom strand is smooth and the other three are barbed. There will be 5 ½ -foot steel posts spaced every sixteen feet, but every fifth post will be a wood post. There will be horizontal wooden braces every 330 ft or wherever there is a terrain change. There are about 21,000 meters (13 miles) of perimeter that need to be fenced at a unit cost of

about $4.00 per meter, equaling a total replacement cost of $84,000. DOE assumes total replacement of the fence every 50 years.

- Because a higher level of security is required for disposal cells, a six-foot chain-link fence with three strands of barbed wire on top will be used. There will be about 5,400 meters of fencing for all five cells, with a cost of about $41.00 per meter, equaling a total replacement cost of $221,400. DOE assumes total replacement of the fence every 50 years.
- Vandalism repairs were also considered, estimated to cost about $3,300 per year for all fences, supports, and gates.

4. Case Study:
   - DOE Grand Junction Long-Term Surveillance and Maintenance office has reported numerous problems with vandalism of the fencing at the 100 or more sites that it manages. It reports that 60 feet of chain link fence were stolen from one of the sites and had to be replaced [146, pg. 5].
   - These physical access controls may still not deter a determined trespasser. The Bureau of Land Management reported an incident in which two men ignored a fence around a closed mine near Virginia City, Nevada. The two men were found in the mine within 75 feet of the mine entrance, asphyxiated from carbon dioxide poisoning. Human intrusion to a contaminated site is less likely to occur when there is layering of multiple institutional controls combined with active management of a site [205, pg. 49].

B. Guards and Security Systems

1. Technical Aspects
   - Depending on the frequency of patrols or checkpoints, guards can effectively prevent human access to a dangerous site.
   - Guards may be a good monitoring control by checking to see that fences and signs are maintained, and making sure that there are no visible signs of contamination.
2. Public Acceptance
   - Guards draw public attention that something is dangerous at a site. This perception may lower local real estate and property values, but may also boost public awareness.
3. Rocky Flats Stewardship Cost Estimate
   - Weekly exterior inspection of perimeter fence by a subcontracted security force will cost about $7,800 per year.
   - Interior inspection of disposal cells and monitoring wells will be done by monitoring personnel, requiring about 200 hours per year at a unit cost of $45.00 per hour. The disposal cell surveillance is more thorough and frequent than the perimeter surveillance.
   - The cost estimate also includes an annual inspection by DOE personnel, compilation of an inspection and monitoring report, and compilation of stakeholder presentation materials, which cost $3,200, $22,500 and $14,000 per year, respectively.
4. Case Study
   - At the Oak Ridge Reservation in Oak Ridge, Tennessee, the Department of Energy Office of Inspector General found that a subcontracted security firm,

Wackenhut Inc., had a contract in place that did not limit worker overtime hours. This contract allowed the security firm to maximize its profits by hiring several part-time guards and having the full-time guards work more overtime. The security company maximized overtime worked by hiring more full-time guards. This contract could have led to $8.1 million being spent for avoidable overtime, and may force the Department to pay $3.2 million in excessive award fees on the contract [170, pg. 3-6].

C. Signs and Markers

1. Technical Aspects
   - Signs are good warning mechanisms, and have varying lifetimes and effectiveness depending on the material from which the sign is made.
   - Signs require at least annual monitoring for operational effectiveness, and frequent maintenance or replacement if problems are noted.
2. Public Acceptance
   - Signs are passive devices that rely on an individual realizing the importance of the warning and acting in a manner that is in his or her best interest.
3. Rocky Flats Stewardship Cost Estimate
   - For the perimeter of the site, DOE assumes that 150 signs posted at the corners and every 500 feet will be required for adequate notice of the potential hazards on the site. The signs will be aluminum with a yellow reflective coating. It is assumed that each sign will be replaced every 25 years, and that fifteen percent of the signs will require replacement each year because of vandalism. Each sign is estimated to cost $49.00 plus $7.00 per hour for installation.
   - For the disposal cells, DOE assumes that 50 signs will be required for adequate notice of the potential hazards in the cell. The signs will be aluminum with a yellow reflective coating. It is assumed that each sign will be replaced every 25 years, and that fifteen percent of the signs will require replacement each year because of vandalism. Each sign is estimated to cost $49.00 plus $7.00 per hour for installation.
4. Case Study
   - Concrete and metal markers have been used at many sites where cover systems hold radioactive waste. The signs often identify the type, volume, and radioactivity of material when it was buried. These markers will last for many years, but there are still problems with corrosion and visibility [154, pg. E.1-3].
   - Signs were used at the Oak Ridge Reservation site in Tennessee, and several metal signs did not last longer than five years because of vandalism and wear. It is not uncommon for signs to be stolen or obliterated by bullet holes, especially in remote locations [76, Reference Pictures].

IV. Ponds and Ditches

1. Technical Aspects
   - On sites with contaminated soil or groundwater, surface water must be collected and stored as there is a potential that a contaminant may move into the surface water. Ditches are often used to collect and transport surface

water to a holding pond, where heavy particles will settle out. Ditches are important if the surface water on the site has a potential to move offsite.

- These ponds may be lined with a low hydraulic conductivity clay, or with a double layer of HDPE geomembranes.
- It may be important to remove the sediments from these ponds on a regular basis to ensure that any eroded contamination is safely removed.

2. Public Acceptance
   - The public may see accessible ponds and ditches as dangerous, so fences or a surface barrier may be warrented.
3. Rocky Flats Stewardship Cost Estimate
   - DOE estimates that it will cost about $3,200 per year for the equipment and operator to remove pond and ditch sediments.

Institutional Controls

The different types of institutional controls have different aspects that work to solve different problems over different spans of time. The choice of institutional controls must be made on a site-specific basis so that their effectiveness is maximized. The complexity involved in the different aspects of institutional controls magnifies the importance of selecting a control to accomplish a specific task. If many specific tasks must be accomplished, then a combination of controls must be used to achieve this; there is no institutional control that applies to every situation.

I. Governmental Controls

Description

- Governmental controls use the authority of the government to either limit the activities that a landowner may undertake or limit the size and location of the structure on the property [191, pg. 11].
- These controls are generally the most effective and accepted of the institutional controls (*Id.*).
- Because neither the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) nor the Resource Conservation and Recovery Act (RCRA) specifically authorizes the EPA to regulate land use in a comprehensive manner, the EPA must rely on state or local governments to establish such controls [191, pg. 37].
- Governmental controls usually work well because they require no negotiation, which is useful when there are many interested parties with conflicting needs [191, pg. 44].
- Governmental controls may not work well because the EPA and the state, which are the lead remedial agencies, are not the parties responsible for their implementation and enforcement. A contractual agreement between the remedial agency and the responsible party (usually the municipality) may be useful [191, pg. 44].
- The effectiveness of governmental controls depends directly on the willingness and capability of the governmental entity to inspect and enforce the control [192, pg. 12].
- The US Nuclear Regulatory Commission (NRC) recommends that governmental controls be used when there are any long-lived radionuclides present at a site. The NRC assumes that government institutions will last longer than private institutions [198, pg. 3].
- Governmental controls are generally direct controls, as the government creates them for a specific purpose [83, pg.3].
- A report by the International City/County Management Association pointed out the importance of working closely with local governments and the need to increase the Association's level of expertise with respect to institutional controls. It has been identified that 75% of local governments presently do not have experience implementing institutional controls related to hazardous waste sites. The report also mentioned that the majority of institutional controls implemented by local governments could be breached without their knowledge [205, pg. 49].

A. Zoning

[Zoning is not applicable to Rocky Flats, except for minerals, as the site will remain in federal ownership and incorporation into a municipality is prohibited.]

1. Purpose

- Zoning is the breakdown of a municipality into areas of compatible use, such as industry, commercial, or residential [83, pg. 4]. It also regulates building size and features.
- Exclusionary zoning is the most probable zoning control that would be used for contaminated sites, because it allows only specified uses within the zone and excludes all others (*Id.*).

2. Specific Zoning Controls
   a. Overlay District
      - This control involves overlaying a new zoning classification and imposing a new set of regulations on previously zoned areas [191, pg. 38]. The overlay district may include the development of a Historical Preservation Zone or an Environmentally Sensitive Area.
      - This overlay district will not change the existing regulations, but will require the submittal and approval of a development plan in order to obtain permits (*Id.*).
   b. Rezoning
      - Rezoning include map and language amendments. Map amendments change the use of a particular parcel by showing changed circumstances or mistakes on the existing map. Language amendments change the text of an ordinance by obtaining a declaratory judgement action [104, pg. 2].
      - The Board of Adjustments for the city and county may grant variances from the literal enforcement of zoning regulations (*Id.*).
      - Rezoning that is inconsistent with a comprehensive plan may be attacked as spot zoning (*Id.*).
   c. Transferable Development Rights (TDR)
      - TDRs are used to transfer development rights from an environmentally sensitive area to more appropriate areas. TDRs have been used in the past to limit residential overcrowding in some areas and encourage growth in other areas [191, pg. 40].
      - TDRs can be used to reduce the risk of takings, if there is developable land to give to the owner of the development rights (*Id.*).
   d. Performance Zoning
      - This method of zoning establishes criteria to control the effects of landowner activity or building at a site, such as pollution, waste removal, water use, glare, dust, vibrations, *etc.* This type of zoning limits the use of the land to those that conform to these criteria [111, pg. 12].
   e. Zoning with Other Types of Controls
      - Most often, a violation of a zoning law is reported by a neighbor [42, pg. 18]. An informational device directed at the public explaining why there is a severe zoning restriction on the property will help to ensure the public watches for any blatant violations.
      - This informational device also helps the public nature of zoning by forcing representatives in the local government to be aware of the community's desire to maintain the law, and thus decreases the chances that the law will be repealed for short-term gains [83, pg. 4].

3. Advantages for Long-Term Control
   - This method of allocating land use has been widely used since 1916, so it is known to work effectively as long as it is monitored and enforced. It will not require changes to the current legal system or new statutory authority (*Id.*).
   - Zoning is implemented through processes that are highly public, allowing for substantial public involvement (*Id.*).
   - Zoning can be very flexible, so any changes at the site can result in a change to the zoning law (*Id.*). As described below, this flexibility also has a downside.
   - Zoning regulations must bear a reasonable, substantial relationship to the health, safety, morals, or welfare of the public [104, pg. 1].
4. Disadvantages for Long-Term Control
   - Zoning laws are different in every municipality [83, pg. 4].
   - Zoning is oriented to avoid conflict. A request for a change is less likely to be approved if neighbors object. On the other hand, a general public agreement about a proposed change may prevent a zoning board from denying the change [83, pg. 5].
   - Zoning laws are meant to be flexible so that an individual landowner is not forced into hardship by maintaining the requirements of the law. Municipalities differ in what is accepted as a sufficient hardship to grant a variance to the requirements [83, pg. 4].
   - Zoning is not static but responds to the land market, and is a part of maintaining the vitality of communities [83, pg. 5].
   - Some argue zoning is contrary to the freedom of choice, in which a person has the option to make the decision whether or not to subject himself to a risk or nuisance without government interference (*Id.*).
   - Zoning has been used to keep intensive land uses (industrial) away from less intensive land uses (residential) but not the reverse. Zoning laws used in the remedial context must stipulate this reverse restriction [191, pg. 38].
5. Responsible Party for Enforcement
   - The zoning laws are made in accordance with state, not federal, statutes, and is enacted and enforced by local governments [2, pg. 20].
   - Local government is usually the best candidate for zoning enforcement because of proximity to the site, resulting in effective monitoring. In addition, it has police power to enforce zoning in the interest of public safety, and usually mirrors the interests of the people living around the site [83, pg. 4].
   - Another agency should oversee the actions of the local government to guard against short-term interests of the landowner (*Id.*).
6. Case Study
   - Arguably, the most well known failure of institutional controls is the Love Canal site near Niagara Falls, New York. The site consists of a landfill containing 21,000 tons of highly toxic chemical wastes generated by the Hooker Plastics and Chemical Corporation, which closed in the early 1950's. At closure, zoning restrictions were placed on the area forbidding residential use, and Hooker placed a deed notice on the property deed when it transferred the land to the Board of Education in 1953. The deed notice included a "hold

harmless" clause that stated that "the Board of Education had been advised by the Hooker Chemical Company that the premises described above have been filled to the present grade level thereof with waste production resulting from the manufacture of chemicals". Despite all of these controls, the Board of Education built a school directly on top of the landfill, and many houses were constructed adjacent to the site. By the summer of 1978, contamination had migrated to the basements of the houses, and was seeping into the schoolyard. This case was the first evidence that institutional controls such as zoning and deed notices have serious limitations in providing long-term protection of human health and the environment [90, pg. 65].

B. Local Permits

[With the exception of permits to mine, local permits are not applicable to Rocky Flats, as the entire site will remain in federal ownership and incorporation into a municipality is prohibited by law.]

1. Purpose
   - Permits are issued by the government to a land user who would like to perform a certain activity, informing the potential user of any restrictions before the activity is authorized [192, pg. 12].
   - At hazardous waste sites, permits can be used to restrict the construction of new wells, limit soil excavation of contaminated subsurface soils, or limit the ability to alter a cap [42, pg. 2].
   - "Miss Utility" permit systems are used in several states which require excavation companies to contact a central agency before beginning work to find out about the location of buried utilities [191, pg. 41].
   - For federally owned sites, permits, licenses, and leases may be issued by the controlling federal agency to restrict activities by land users [191, pg. 88].
2. Advantages for Long-Term Control
   - A site can take advantage of existing permit restrictions and apply them to site-specific situations [192, pg. 12].
   - Permits are effective at preventing future users from undertaking an inappropriate activity [188, pg.27].
3. Disadvantages for Long-Term Control
   - Permits will not prevent current inappropriate activities (*Id.*).
   - Permits have a narrow focus, so they will not prevent all possible activities that could harm human health and the environment [192, pg. 12].
   - Requirements may be changed at any time by the local government (*Id.*).
   - Permits may not be required for government-based construction.
4. Responsible Party for Enforcement
   - Permits are usually the responsibility of the local government (*Id.*).
5. Case Study
   - A Building Permit Survey system has been in place for 25 years at the Uranium Mill Site in Grand Junction. This system forces builders to search the Colorado Department of Public Health and Environment (CDPHE) records for information on uranium mine tailings on the property, then check to see if tailings still remain. The use of permits eventually failed because a

project to build a recreational path through the site was carried out by the city itself, which was not required to obtain a permit [34, pg. 13].

- A "miss-utility" program (called "One Call for Brownfields") is being used in Portland, Oregon This program uses the format of the Oregon Utility Notification Center, which allows excavation contractors to call in to find where the subsurface utility lines run at a site. The Notification Center then works with the Oregon Department of Environmental Quality to notify the contractor if he is working in a contaminated area and where any caps or subsurface contaminants are located. This program is also a good method of finding if any construction on the city's Brownfields is taking place of which the regulators may not be aware. The pilot project was a success, with over 200 calls on eight Brownfield sites in eight months [56, pg. 1-9].

C. Tailored Ordinances

[Tailored ordinances are not applicable to Rocky Flats, as the entire site will remain in federal ownership and incorporation into a municipality is prohibited by law.]

1. Purpose
   - Tailored ordinances are placed on access or use of certain areas, such as a ban on fishing or swimming [192, pg. 13].
   - They are based on the police power of the local government [207, pg. 14].
2. Advantages for Long-Term Control
   - They can take advantage of existing permit restrictions by applying them to site-specific situations [192, pg. 13].
3. Disadvantages for Long-Term Control
   - These controls must be communicated through a posting of the ordinance. Postings alone may not be effective in preventing incidental contact with the contamination (*Id.*).
4. Responsible Party for Enforcement
   - Local governments are responsible for enforcement of ordinances (*Id.*).
5. Case Study
   - At the Cannons Engineering site in Bridgewater, Massachusetts, the town of Bridgewater used an ordinance to enter into a Declaration of Restrictions with the EPA that limited future municipal uses of the site. The ordinance worked, but there were limitations on recording the Declaration because the State of Massachusetts uses the name of the property owner to search for the Declaration, instead of the site name and location [37, pg. 21].

D. Land Use Planning or Siting Restrictions

1. Purpose
   - Siting restrictions can be used to prevent certain land uses to areas that are prone to natural hazards, such as flood plains or fault lines [42, pg. 2], and may also be applied to a highly contaminated area.
   - California requires an environmental impact review of proposed construction or other activities approved by state or local governments [84, pg. 6]. The review might be a good check to ensure that any new construction plans will not affect the physical controls on a site, or will not be in danger of releasing subsurface contamination at the site.

- Several restrictions exist for developing in a floodplain, which are laid out by the US Army Corps of Engineers or the Federal Emergency Management Agency [84, pg. 7]. The long-term stewardship plan for land use at a contaminated site and a floodplain may contain similar restrictions.

2. Advantages for Long-Term Control
   - There are often set laws for siting restrictions at all levels of government, and there are agencies that have successful management systems laid out (*Id.*).
3. Disadvantages for Long-Term Control
   - Site restrictions usually apply to new construction, so current laws may not apply to existing structures (*Id.*).
4. Responsible Party for Enforcement
   - For a normal siting restriction, the state or local government would take responsibility for enforcement and monitoring [192, pg. 13].
5. Case Studies
   - At the Mound Site near Miamisburg, Ohio, the DOE established an Interim Land Use Policy, because the DOE had not yet released control of the land to the local government, but wanted to lay out land use controls for companies subletting the land. The policy identified fifteen categories of authorized uses, established performance standards including avoidance of hazards and pollution, laid out requirements pertaining to radioactive waste, and required a risk assessment of the sublessees' work. This policy was enforced by prohibiting a business from receiving a lease or conveyance without being issued a "Certificate of Appropriateness" by a committee [35, pg. 25].

E. Groundwater Use Restrictions

1. Purpose
   - These restrictions are directed at limiting or prohibiting certain uses of groundwater, and may be implemented by establishing groundwater management zones, or by capping or closing wells according to the state well permitting system [191, pg. 42].
   - Several states include water use restrictions in their regular construction permits or in a deed restriction for sites surrounding contaminated water [83, pg. 5].
2. Advantages for Long-Term Control
   - These restrictions can take advantage of existing water use restriction laws, and apply them to the specific site situation [192, pg. 13].
   - Provision of an alternate source of drinking water strengthens compliance with groundwater use restrictions. In addition, a water testing program will help groundwater well users determine if their water is contaminated [46, pg. 41].
3. Disadvantages for Long-Term Control
   - These water use restrictions vary from state to state in technicalities. The use of groundwater restrictions must be checked to ensure that an individual state's guidelines for using these restrictions are not too vague or too specific for a hazardous waste site [192, pg. 13].

4. Case Study
    - At the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, DOE created a zone delineating an area of contaminated groundwater, which extended through a residential neighborhood. Any resident within this zone was eligible for a free hookup to city water sources, on the condition that they close all wells and promise not to use groundwater on their property. This control failed at one property, where a lessee used contaminated groundwater for eleven years, because his landlord did not want to give up the water rights for the property, which extended much further than the DOE's zone. There was no contingency for renters in DOE's plan, so the family suffered multiple health problems over the years [65, pg. 1].

II. Proprietary Controls

Description

- Proprietary controls are related to the intricacies of owning private property. Private property owners have certain rights and responsibilities that have been established over time in the common law system specific to each state [83, pg. 6]. A proprietary control involves one owner exerting his rights to control the land use of another owner.
- The proprietary control itself should contain, at minimum, the following information as recommended by the NRC [198, pg. 5]:
    1. A legal description of the property affected
    2. The name(s) of the current owner(s) as reflected in public land records and the conditions of payment for the property interest
    3. The parties who can enforce the control and are responsible for payment
    4. A statement of the hazard posed by the contamination on the site and the nature of the restriction, limitation or control
    5. The duration of the control, or conditions that would allow an end to the control
    6. Permission for regulators to monitor compliance with controls
    7. Permission to install and maintain physical controls
    8. The location of the public copy of the final radiation status report
    9. The name of owners and enforcers so that any changes in the future do not limit the power of the control
- Development of new proprietary controls is a function of state law [191, pg. 18-19]. Relatively little state or federal government staff time would be needed to administer a proprietary interest (depending on the owner of the rights), but periodic site visits are necessary for high risk sites [84, pg. 4].
- Most propriety controls can be written in a way that restrictions can be passed onto subsequent owners (i.e. it "runs with the land") [83, pg. 9].
- Deed restrictions encompass all enforceable instruments such as easements and covenants, but are not a specific control tool alone [191, pg. 9].

A. Easements

1. Purpose
    - An easement is a conveyance of a property right from a principal landowner to another party, which gives the second party rights with regard to the first party's land [192, pg. 15]. It may be given freely, or may be sold by the owner of the property [84, pg. 3].

- An affirmative easement allows the holder to enter upon or use another's property for a particular purpose, such as checking groundwater monitors or checking for compliance with other controls [192, pg. 15].
- A negative easement imposes limits on how the principal landowner can use his property (*Id.*). This type of easement is more useful for an institutional control, as it is prohibitive in nature [191, pg. 21].
- An easement "in gross" is held by a party who does not own an adjacent parcel of land. A government agency such as the EPA may hold the easement but not fully own the property [192, pg. 15].
- An appurtenant easement is held by the owner of a neighboring property, and is much easier to enforce than an "in gross" easement because the restrictions directly benefit the neighbor.
- The most important part of writing an easement is to state its intent and scope clearly so that its purpose is not questioned or misinterpreted over time [191, pg. 21].

2. Specific Types of Easements
   a. Conservation Easements
      - This easement limits uses of the property to those that are compatible with the conservation of natural resources, environmental values, scenery, or other specified purposes. These easements are binding on future users of the property, and may be held by land trusts, charities, or government agencies (*Id.*).
      - These easements are generally used to protect open space, not to limit exposure to dangerous contaminants [83, pg. 9].
      - Another method of creating a conservation easement would be to have a land trust or charitable institution buy the development, natural resource, and water rights on the property [84, pg. 3].
   b. Hazardous Waste Easements
      - This easement would be similar to a conservation easement, but would be used primarily to limit human and ecological exposure to contaminants [83, pg. 9].
      - State laws govern property rights, thus the development of a hazardous waste easement should be enacted at the state level. This easement has been enacted in only three states. Still, the method of drafting a model or uniform law and encouraging states to adopt it has worked in almost every state (*Id.*).
3. Case Study
   - At the Mound Site near Miamisburg, Ohio, the DOE polluted an offsite city owned area with plutonium. The DOE obtained an easement to clean up the land by gaining ownership of the land for five years. The DOE was required to pay $4.6 million to the city for damages, but the easement served its purpose by restricting access to the public during cleanup [35, pg. 26].

B. Covenants

1. Purpose
    - A covenant is a promise made by one landowner to another, in connection with a conveyance of property, generally agreeing to refrain from using the property in a certain manner [191, pg. 24].
    - In a minority of the states, including Colorado, a covenant is not a legal interest in a property, but a binding contract. In other states, a covenant is both an interest in the property and a binding contract. A covenant must "touch and concern the land", not the owners, to be binding [85, pg. 1].
    - As an example, if a federal agency transfers real property to a non-federal entity, CERCLA Section 120(h) requires the agency to include a covenant asserting that all remedial action necessary to protect human health and the environment from any hazardous substances has taken place [190, pg. 1].
    - This covenant also states that any action which disturbs or contributes to existing contamination makes anyone involved in that action a PRP (*Id.*).
2. Advantages for Long-Term Control
    - Covenants can serve as an institutional control when remediated property is transferred from one owner (such as the DOE) to another (a developer or private individual) [192, pg. 16].
3. Disadvantages for Long-Term Control
    - Covenants have different formal requirements than easements that make them less flexible and effective in enforcing the restrictions over the long term [191, pg. 24].
    - Covenants are only binding on subsequent owners when notice is given to the subsequent owner, there is a clear statement of intent to bind future owners, the agreement "touches and concerns" the land, and there is vertical and horizontal privity between the parties. Horizontal privity means that only a contract party may claim relief for a breach in contract, while vertical privity means that each party in a distribution chain only has a contract with the party ahead of him or her in the chain [192, pg. 16].

C. Restrictive Covenants

1. Purpose
    - A restrictive covenant is similar to zoning in that it prohibits specific types of development or construction on a property. Restrictive covenants are different in that zoning is a policing mechanism while a restrictive covenant relies on private controls [84, pg. 4].
    - Rather than being between two parties, like the covenant explained above, a restrictive covenant is usually a promise between a group of landowners in a certain area (*Id.*). There is no central enforcer, but the landowners enforce each other using state courts.
2. Advantages for Long-Term Control
    - Restrictive covenants are usually between multiple landowners, and can be enforced by and against each other [83, pg. 6].
    - A restrictive covenant will run with the land if it is between several neighboring landowners, placed by mutual consent, or initially created by a developer (*Id.*).

3. Disadvantages for Long-Term Control
   - Restrictive covenants are usually intended to benefit the included parties rather than the public [83, pg. 6]. The interests of a single party may be forced upon the other landowners, putting the public and environment at risk.
4. Case Study
   - At the Mound Site near Miamisburg, Ohio, the DOE is considering several deed restrictions that still may be put in place when it transfers its property to the city of Miamisburg. One will restrict use to industrial buildings, one will prevent the installation of potable water wells until the groundwater can be proved to be at acceptable standards, another will restrict any excavation on the site, one will monitor all contaminated soil transported from the site to avoid spreading contaminants to the community, and a final restriction will allow regulatory agency access to the site. These restrictions are to be enforced both by the regulatory agency and by mutual monitoring by the different site users [35, pg. 29].
   - The DOE Oak Ridge Operations Office in Oak Ridge, Tennessee transferred land to a local community with deed restrictions prohibiting the use of groundwater because there is a contaminant plume that might eventually migrate into the area. DOE did not conduct regular monitoring to ensure the deed restriction was being enforced and discovered that the community later drilled groundwater wells to irrigate a golf course. DOE then mandated immediate removal and threatened a reversion of property interest [205, pg. 47].

D. Reversionary Interest
1. Purpose
   - A reversionary interest is created when a landowner deeds property to another landowner, but the deed specifies that the property will revert to the original owner under specified conditions. This control places a condition on the transferee's right to own and occupy the land [191, pg. 17].
2. Advantages for Long-Term Control
   - This control is binding on any subsequent purchasers in the chain of title (*Id.*). It is still important to keep any new owners informed of the condition on their ownership so that this control does not need to be unnecessarily enforced.
3. Disadvantages for Long-Term Control
   - The effectiveness of a reversionary interest is based on the future owners complying out of fear that the original owner will reclaim the property if a restriction is violated (*Id.*).
4. Case Study
   - At the Mound site near Miamisburg, Ohio, the DOE is using lease controls, which can be considered a form of reversionary interest. This institutional control binds both the development corporation and its sublessees to avoid releasing any new contamination or disturbing existing contamination. The penalty for violations is loss of the lease and a return of the land to DOE. This control is working fairly well, but there has been one incident of a copper discharge in the site's wastewater that could not be traced to DOE or the

sublessee. In addition, all lease controls would become invalid if the property were sold by the development corporation [35, pg. 24].

E. State Use Restrictions

1. Purpose
   - State statutes provide owners of contaminated property with the authority to establish use restrictions specifically for contaminated property [192, pg. 18].
   - Colorado has passed Bill 01-145, Concerning the Enforceability of Environmental Real Covenants, which establishes a state program for controlling land uses in areas with residual contamination [12a].

F. Governmental/Proprietary Control Hybrids (Wildlife Refuge)

1. Purpose
   - When the land in question is owned by a government agency, it may be transferred to another government agency for management, or an act may be passed to protect the area. The land ownership by the government constitutes the proprietary control while the act constitutes the governmental control [16, pg. 7].
   - In the case of the Rocky Mountain Arsenal and Rocky Flats, the enabling legislation specifies that the contaminated portions of the sites remain in the control of the Department of Defense or DOE, respectively [138a].
2. Advantages for Long-Term Control
   - At the Arsenal, any conveyance of property is subject to perpetual restrictions, including a ban on residential or industrial use, and the use of groundwater [16, pg. 7].
   - The Arsenal protects endangered species of animals, and provides guaranteed open space in the future (*Id.*).
   - The Department of Interior and the U.S. Fish and Wildlife Service, which are responsible for maintaining wildlife refuges, have long-term land controls of their own which have been shown to work (*Id.*).
   - Creating a wildlife refuge is a public proceeding, which means there could be tremendous public scrutiny of proposed uses (*Id.*)
3. Disadvantages for Long-Term Control
   - Refuge management is not responsible for managing the site contamination, and may not have the tools to implement restrictions. Agencies responsible for implementing restrictions may not be on site, and may be unable to obtain funding for implementation of long-term activities.
4. Case Study
   - Under the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992, legislation was enacted to create a wildlife refuge on that site (*Id.*). The site cleanup has been proceeding successfully because the Army, the EPA, and the Bureau of Fish and Wildlife Services are cooperating on several projects. A benefit of government ownership is the ability to use many different experimental physical controls, such as ET covers.
   - DOE is carrying out preservation activities at Idaho National Engineering and Environmental Laboratory, Savannah River, Oak Ridge, Los Alamos, Lawrence Livermore National Laboratory, and Rocky Flats [205, pg.35].

- The Rocky Flats Wildlife Refuge Bill of 2001 establishes a refuge at Rocky Flats after the completion of cleanup activities. The definition of what land will be transferred will be determined in the Memorandum of Understanding between DOE and DOI, to be drafted by December 2002. By June 2002, the Department of the Interior must establish a Comprehensive Planning Process that would involve the Rocky Flats Coalition of Local Governments, the Rocky Flats Citizens Advisory Board and others.

G. Historic Preservation

1. Purpose
   - The National Historic Preservation Act (NHPA) is a consultation and mitigation mechanism to protect historic resources [84, pg. 6].
   - This act establishes the National Register of Historic Places (NRHP) and protects properties "eligible" for the Register, whether or not they have been registered in the past (*Id.*).
2. Advantages for Long Term Control
   - Either the contaminated sites could be preserved for their historical significance in the Cold War, or the Act could be used as a template for protecting Superfund sites after cleanup (*Id.*).
   - Consultation may provide a good warning device for enforcement agencies such as the EPA (*Id.*).
3. Disadvantages for Long Term Control
   - Consultation is not effective as an institutional control in preventing changes in land use (*Id.*).
4. Case Studies
   - The NRHP has listed a massive crater that was created by a nuclear explosive excavation experiment in New Mexico and another unspecified highly polluted site. The nomination process is difficult and time consuming because there is no central agency to research and record the necessary information to gain eligibility. The landowner has the responsibility to complete the nomination process and, if accepted, maintain the site according the NHPA's guidelines [31, pg. 2].
   - Cemeteries are historically preserved institutions that have existed almost as long as man has existed. They utilize monitoring and maintenance, passive physical controls such as fences and tombstones, institutional access restrictions, and burial records. Experience shows that cemeteries still are vandalized or built over (examples are Pere-Lachaise cemetery in Paris). Many have a historical governmental or religious institution meant to protect them over many generations. They may have large costs as well, such as Arlington Cemetery, which has a budget of $11 million a year, while others have a perpetual care trust fund to avoid falling into neglect [92, pg. 34].

H. Liability Following Property Transfer

1. Purpose
   - Section 3158 of the National Defense Authorization Act of 1998 allows the Secretary of Energy to hold harmless a person or entity to whom property has been transferred against any claim for injury related to the release or threatened

release of a contaminant as a result of DOE activities at a defense nuclear facility [205, pg. 65].

- This exemption does not apply if that the person or entity knowingly contributed to any such release (*Id.*).
- CERCLA states that anyone who contributes to the contamination at a site may be held liable as a PRP [195]. This liability includes waste that is transferred from one property to another. An implication of this liability may be that sites will store waste onsite rather than accept a share of the responsibility of a failure at a site to which they transferred waste.
- EPA may grant an agreement "not-to-sue" if a person reuses a contaminated site while following any restrictions placed on the site (*Id.*)

III. Enforcement Tools

Description

- Oversight and regulatory agencies such as the EPA and the state have the power to enforce laws and agreements, whose violation could affect public safety, health, and the environment.
- Enforcement authority is used to prohibit a party from using land in certain ways or from carrying out certain activities at a specified property [191, pg. 46].
- Enforcement tools are generally easier to regulate than governmental and proprietary controls, as the agency is not dependent on a third party (*Id.*).
- Enforcement tools are typically binding only on the original signatories of the agreement or binding only parties to whom it is issued in the case of a Unilateral Administrative Order (*Id.*).
- These controls are best suited for short-term control in which the property is not likely to change hands or the contamination is short-lived [191, pg. 51].

A. Administrative Orders

1. Purpose
   - An order directly restricting the use of property by a named party. This order can also be used to restrict the use of land by a non-liable party [191, pg. 18].
2. Advantages for Long-Term Control
   - EPA has broad scope of authority to issue orders to protect public health and the environment through Section 106 of CERCLA (*Id.*).
   - These controls can be implemented without the execution of any further property instruments (*Id.*).
   - The order may include provisions for the bound parties to notify the agency of any potential purchaser so that the agency may reissue the order (*Id.*).
   - This control does not require the agreement of the landowner, although it is advantageous to have consent in the long run (*Id.*).
   - Unilateral orders can be easily modified in the event that the control situations change (*Id.*).
3. Disadvantages for Long-Term Control
   - Orders do not bind subsequent owners or parties who are not named (*Id.*).
   - An order to restrict a non-liable party may result in a claim for compensation under Section 106(b) of CERCLA (*Id.*).

4. Case Study
    - The Uranium Mine Tailings Radiation Control Act program was carried out by the DOE in Grand Junction, Colorado, in a similar manner to an administrative order. The DOE worked to remove uranium mine tailings from thousands of sites in the city that had used the tailings as fill. The program was based on the compliance of the landowners, allowing them to choose if they wanted the tailings removed from their property. Many accepted the offer, but 200 out of 5000 declined the cleanup, exemplifying the limitations of a voluntary order [188, pg. 30].

B. Consent Decrees
1. Purpose
    - A consent decree is signed by a judge and documents the settlements of an enforcement case. The purpose of restricting land use is the same as an administrative order (*Id.*).
2. Advantages for Long-Term Control
    - A consent decree can be used to require the landowner to file a separate instrument conveying a proprietary control such as an easement or covenant to the EPA or a third party (*Id.*).
    - A consent decree can be used to require the landowner to notify successors-in-title of the consent degree and its conditions, and also to notify the EPA of any new ownership (*Id.*).
3. Disadvantages for Long-Term Control
    - Consent decrees are not binding on subsequent property owners (*Id.*).
    - Consent decrees cannot be used against federal agencies (*Id.*).
    - The Institutional Controls Workgroup for the EPA believes it is not good practice to rely exclusively on the terms of a consent decree for a long-term land use control. A settlement between the PRP and the EPA does not bind other parties. Consent decrees are most effective in forcing the PRP to institute other long-term controls [191, pg. 49].
4. Case Studies
    - The EPA often requires local governments to place an ordinance on a property as part of a Superfund consent decree, and has held the municipality liable when the municipality failed to strictly enforce the terms of the ordinance. The EPA has in at least one case used its broad authority under a consent decree to assess stipulated penalties against a municipality for failing to obtain a permit under its own ordinance. This threat of liability may make local governments refuse to accept the terms of the consent decree [20, pg. 3].
    - This threat may be avoided if the EPA provides the local government or reuse organization with a covenant not to sue in the consent decree. At the Denver Radium Site, the EPA provided Home Depot (the reuse organization) such a covenant because of the benefits the company may bring to the community [138, EPA, pg. 2].
    - At the Industri-Plex site in Woburn, Massachusetts, a custodial trust was developed by the PRPs to handle the site's redevelopment and some cleanup. The custodial trust has been able to function successfully in creating private/public partnerships because of a consent decree from the EPA which

effectively severed liability for the trust's redevelopment activities. There are two reasons, however, why this consent order may not be in the best interests of public health and the environment. For one, the EPA is using the site as an example of national initiative that aims to establish the beneficial reuse of Superfund sites, and is therefore considering less stringent institutional controls [90, pg. 63]. Second, the Industri-Plex site is in a high-value area, thus the PRPs are more interested in the future use of the site than in the cleanup and long-term control processes [90, pg. 54].

C. Comprehensive Five-Year Review

1. Purpose
   - The CERCLA five-year review process is required of all National Priority List sites that leave residual contamination behind after closure. The National Contingency Plan, as implemented in 40 CFR 300.430(f)(4)(ii), states:

     The five-year review must include an assessment of every possible factor that may influence the long-term protection of human health and the environment. The CERCLA five-year review should contain three elements:
     Compliance monitoring,
     Performance monitoring, and
     Review of the land use and exposure assumptions.
   - The five-year review must include an assessment of applicable new and modified state, federal, or local laws; an assessment of the land use controls, the functionality of the physical controls; the functionality of the monitoring, maintenance, and monitoring; the functionality of the information management systems; a reevaluation of the baseline conditions, cleanup levels, exposure assumptions, future land use assumptions; and any other factors that may impact the protectiveness of the remedy and associated stewardship controls.
   - Executive Order 12580 establishes the requirements for conducting five-year reviews at DOE sites. DOE is responsible for conducting the five-year reviews and EPA issues a finding of concurrence or non-concurrence.
2. Advantages for Long-Term Control
   - The entity responsible for the remedy also has the direct responsibility for routine reevaluation of the remedy effectiveness.
   - Scheduled reviews can affirm the adequacy of monitoring and O&M, and can reevaluate new information or technologies.
3. Disadvantages for Long-Term Control
   - The entity responsible for the remedy also has the direct responsibility for routine reevaluation of the remedy effectiveness.
   - As the lead agency, DOE is only required to obtain concurrence from EPA and to notify the state agency or the public regarding the review. Thus, external oversight or enforceability is lacking.

IV. Informational Devices

Description

- Informational devices are tools that often rely on public record systems, used to provide public information about risks and contamination [192, pg. 22].
- Informational devices are passive controls, and as long as the information exists and is available, it may effectively discourage inappropriate land users from acquiring the property (*Id.*).
- Informational devices are an easy control to implement as there are no conveyances or negotiations necessary (*Id.*).
- These controls have no effect on a property owner's legal rights regarding the future of the site, and may actually discourage improper uses of the site by creating a perceived liability risk (*Id.*).

A. Deed Notices

1. Purpose
   - A deed notice is an informational document filed in public land records that alerts anyone searching the records to important information about the property (*Id.*). This information may include where the site is located, what kinds of contaminants are present, and what the risks of exposure are, and describe undesirable activities on the site [192, pg. 22]
2. Advantages for Long-Term Control
   - A deed notice may discourage inappropriate land use by alerting the public about dangers.
3. Disadvantages for Long-Term Control
   - Deed notices are not traditional real estate interests, so proper practice in using them is not well established. There are variations from state to state on how the notice will be recorded if it is available, how it should be drafted, and who is entitled to revoke it (*Id.*).
   - It is important to obtain the property owner's consent prior to filing the notice to avoid the risk of claims for slander of title (*Id.*).
   - For a non-owner of a contaminated property, the information is not easily noticed unless a deed search is done.
4. Longevity
   - This informational control will last as long as the public land records last. Its effect is non-enforceable so it will retain its passive sense through perpetuity.

B. Public Education

1. Purpose
   - Public education can be carried out through meetings, information packets, public service announcements, children's education, etc.
2. Advantages for Long-Term Control
   - Information can be memorialized into each generation of local residents. The communities will understand other institutional controls, and know where contamination is located and how to avoid being contaminated
3. Disadvantages for Long-Term Control
   - If the public forgets or the source of information is eliminated or inaccessible, then the public education will fail.

- People have to be willing to learn for this control to work.

4. Case Studies
   - "Pb Possum" children's coloring books, by Annabelle Fuhr, are a good way for children to find out about avoiding contamination [191, pg. 125].
   - At the Cannons Engineering site in Bridgewater, Massachusetts, the EPA held public education sessions, but because the Site was located in an industrial area, the public did not see a risk of exposure and stopped attending [191, 23].

V. Planning Systems

Description

- These devices are institutional controls that are an integral part of stewardship, but do not fit into the categories of restricting access or informational devices.

A. Planning Systems

1. Purpose
   - Planning systems can be considered an informational basis for controls, a template or protocol for actions, and an informational reference. Thus, these controls may fit into the categories as parts of governmental, proprietary and enforcement controls, or may not fit into a category at all.
2. Aspects of Long-Term Control
   - A planning system is a way to ensure future decisions will be consistent with currently known concerns, such as the protection of human health and the environment, by not breaching physical controls at contaminated sites.
   - These planning systems first compile all useful and relevant information on a subject of concern (such as groundwater contamination), and then develop a future course of action. It should be constantly updated with any new information, and old or irrelevant information should be discarded.
3. Examples of Planning Systems
   a. Environmental Master Plan (EMP)
      - This is a plan used on the state or county level that integrates land use controls and controls on new development in a particular type of site. For instance, an EMP may be written to forbid any future development on all uranium mining sites in a state or county [37, pg. 53].
   b. Base Master Plan
      - This is the plan for land-use consistent with a ROD for a closed military base. The EPA stresses that these are not dependable devices because they are only used for construction projects and can easily be changed by a commanding officer [191, pg. 84].
   c. Geographic Information Systems (GIS)
      - Federal facilities are beginning to develop extensive computerized databases that track land uses and restrictions on properties. GIS can be a very useful institutional control as it is a visual device. A ROD may specify that a site must be marked on these maps [191, pg. 86].
      - In Commerce City, Colorado and Emeryville, California, local governments are setting up environmental information databases that include locations of soil and groundwater contamination. The databases include GIS maps that show properties with historical contamination such

as brownfields and properties that have land use restrictions. The annual costs for Commerce City are $170,000 and $36,000 for Emeryville [111, pg. 33].

APPENDIX B

REGULATORY AUTHORITY TABLE

Environmental Regulatory Authorities for Selected Major DOE Facilities

(As of February 6, 2001)

Statute[1] / State/Facility	RCRA			CERCLA	CAA[2]	SDWA[3]	CWA	TSCA
CA/LBNL	**BA**	**CA**	**MW**	*CA	CA (EPA Rad NESHAP)	Joint CA and EPA (UIC)	CA (except sludge)	EPA
	CA	CA	CA					
CA/LLNL	CA	CA	CA	EPA	CA (EPA Rad NESHAP)	Joint CA and EPA (UIC)	CA (except sludge)	EPA
CO/RF	CO	CO	CO	EPA	CO (EPA Rad NESHAP)	Joint CA and EPA (UIC)	EPA	EPA
ID/INEEL	ID	ID	ID	EPA	ID (EPA Rad NESHAP)	ID (UIC)	EPA	EPA
IL/Argonne	IL	IL	IL	*IL	IL (EPA Rad NESHAP)	IL (UIC)	IL (except pretreatment and sludge)	EPA
KY/Paducah	KY	KY	KY	EPA	KY (EPA Rad NESHAP)	EPA (UIC)	KY (except sludge)	EPA
NM/LANL	NM	NM	NM	**NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NM/Sandia	NM	NM	NM	*NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NM/WIPP	NM	NM	NM	*NM	NM (EPA Rad NESHAP)	NM (UIC)	EPA	EPA
NY/BNL	NY	NY	NY	EPA	NY (including Rad NESHAP)	EPA (UIC)	NY (except pretreatment and sludge)	EPA
NY/WV	NY	NY	NY	*NY	NY (including Rad NESHAP)	EPA (UIC)	NY (except pretreatment and sludge)	EPA
NV/NTS	NV	NV	NV	***NV	NV (EPA Rad NESHAP)	NV (UIC)	NV (except pretreatment and sludge)	EPA
OH/Portsmouth	OH	OH	OH	*OH	OH (EPA Rad NESHAP)	OH (UIC)	OH (except sludge)	EPA

OH/FEMP	OH	OH	OH	EPA	OH (EPA Rad NESHAP)	OH (UIC)	OH (except sludge)	EPA
SC/SRS	SC	SC	SC	EPA	SC (including Rad NESHAP)	SC (UIC)	SC (except sludge)	EPA
TN/ORR	TN	----	TN	EPA	TN (including Rad NESHAP)	EPA (UIC)	TN (except sludge)	EPA
TX/Pantex	TX	TX	TX	EPA	TX (EPA Rad NESHAP)	TX (UIC)	TX (except sludge)	EPA
WA/Hanford	WA	WA	WA	EPA	WA (process to gain Rad NESHAP authority has begun but EPA will have authority until process complete)	WA (UIC)	EPA	EPA

Key

Endnotes

1. Under a number of environmental statutes EPA can delegate/authorize a State to manage particular aspects of an environmental program. In those instances where a State has not been delegated/authorized to manage a particular environmental program, EPA manages the program. There are also some environmental programs that EPA does not or cannot delegate/authorize the State to manage. Therefore, depending upon the statute EPA could retain authority over the entire program, delegate/authorize the State to manage some programs, or delegate/authorize the State to manage all programs.

2. A key regulatory program of the Clean Air Act (CAA) is the requirement that States develop State implementation plans (SIPs), which when complied with would enable all areas in the State to attain and maintain the National Ambient Air Quality Standards for criteria pollutants (sulfur dioxide, particulate matter, nitrogen dioxide, carbon monoxide, ozone and lead). All of the States in the table have SIPs approved by EPA (with some exceptions to certain provisions identified in 40 CFR Part 52 for each State). There are other regulatory programs established under the CAA in which EPA must approve State rules and requirements for implementing the program. One example of such a program is the State air operating permit program and the corresponding EPA regulations in 40 CFR Part 70. In addition, there are CAA regulatory programs for which States have the discretion to request approval from EPA to run the program. An example of such a program is the Radionuclide National Emission Standards for Hazardous Air Pollutants (NESHAP) program (40 CFR Part 61, Subpart H). Only a few states have been delegated authority by EPA to run the Radionuclide NESHAP program and these states are identified in the table. Additional data collection is needed to develop a comprehensive list of state programs approved by EPA.

3. All the States in the table have been granted primacy by EPA for the public water system program under the SDWA. A separate delegation is needed from EPA for a State to implement the Underground Injection Control program. The table lists those States that have been given full authority or joint authority by EPA.

Statute Abbreviations
RCRA = Resource Conservation and Recovery Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CAA = Clean Air Act
SDWA = Safe Drinking Water Act
CWA = Clean Water Act
TSCA = Toxic Substances Control Act

Facility Abbreviations
Argonne = Argonne National Laboratory
BNL = Brookhaven National Laboratory
FEMP = Fernald Environmental Management Project
Hanford = Hanford Site
INEEL = Idaho National Engineering and Environmental Laboratory
LANL = Los Alamos National Laboratory
LBNL = Lawrence Berkeley National Laboratory
LLNL = Lawrence Livermore National Laboratory
Paducah = Paducah Gaseous Diffusion Plant
Pantex = Pantex Plant
Portsmouth = Portsmouth Gaseous Diffusion Plant
NTS = Nevada Test Site
RF = Rocky Flats
Sandia = Sandia National Laboratory
SRS = Savannah River Site
WIPP = Waste Isolation Pilot Plant
ORR = Oak Ridge Reservation
WV = West Valley Demonstration Project

RCRA Abbreviations
BA= State has Basic Authorization from EPA to run its basic RCRA Program
CA= State has specific Corrective Action Authorization to run the corrective action program
MW = State has specific Mixed Waste Authorization to regulate mixed waste

Other Abbreviations
EPA = U.S. Environmental Protection Agency
Rad = Radionuclide
NESHAP = National Emission Standards for Hazardous Air Pollutants
UIC = Underground Injection Control Program

Symbol Definitions
* = site not on the National Priorities List under CERCLA, but environmental remediation activities are conducted under State RCRA authority.
** =site not on the National Priorities List under CERCLA, but environmental remediation activities are conducted under State RCRA authority. However, CERCLA guidelines for remediation are followed for remediating project sites that contain hazardous substances not covered by RCRA.
*** = site not on the National Priorities List under CERCLA. However, to address environmental restoration activities for different parts of the site, NTS entered into an agreement with the State of Nevada and DOD pursuant to CERCLA 120 (a)(4) which provides that state law shall apply to removal and remedial actions for federal facilities not on the NPL and RCRA 3004 (u) which governs continuing releases at permitted facilities.
---- = State believes that it has adopted a rule that is analogous to the federal rule, but EPA has not yet authorized the state program

Sources

1. Office of Solid Waste, Environmental Protection Agency, "State Authorization", http://www.epa.gov/epaoswer/hazwaste/state/index.htm (data as of 09/30/00)

2 Office of Solid Waste, Environmental Protection Agency, U.S. Map Showing Authorization Status of Key RCRA/HSWA Rules, http://www.epa.gov/epaoswer/hazwaste/state/authstat.htm, click on Corrective Action (data as of 09/30/00)

3. Office of Solid Waste, Environmental Protection Agency, U.S. Map Showing Authorization Status of Key RCRA/HSWA Rules, http://www.epa.gov/epaoswer/hazwaste/state/authstat.htm, click on Mixed Waste (data as of 09/30/00)

4. Office of Water, Environmental Protection Agency, http://www.epa.gov/safewater/uic/primacy.html (updated 06/15/00)

5. Office of Water, Environmental Protection Agency, "NPDES Permit Program Frequently Asked Questions", http://www.epa.gov/owm/faq.htm (updated 09/16/98)

Last Update: February 6, 2001
Point of Contact: Beverly Stephens at Beverly.Stephens@eh.doe.gov or (202)586-5942

APPENDIX C

LONG-TERM STEWARDSHIP BIBLIOGRAPHY

Long-Term Stewardship Bibliography

[1] Alm, A. "Fourteen Not So Easy Steps to a Successful Environmental. Management Program". ELR News and Analysis. 28 ELR 10519. September 1998.

[2] Applegate, J. Dycus, S. "Institutional Controls or Emperor's Clothes? Long-Term Stewardship of the Nuclear Weapons Complex". ELR News and Analysis. 26 ELR 10109. March 1996.

[3] Association of State and Territorial Solid Waste Management Officials (ASTSWMO). "Survey of State Institutional Control Mechanisms". Washington, D.C. December 1997.

[4] ASTM. "Standard Guide for the Use of Activity and Use Limitations, Including Institutional and Engineering Controls". Draft 9.

[5] Averbeck Environmental Insurance Brokers. "Let Us Help You Turn Contaminated Property Into Revenue Generating Property. Presentation.

[6] Bartz, S. Linnartz, A. Becker, J. "Long-Term Stewardship in the WISMUT Project". Uranerz. Presentation at the Long-Term Stewardship Workshop in Denver. June 2-3, 1998.

[7] Borinsky, S. "The Use of Institutional Controls in Superfund and Similar State Laws". Fordham Environmental Law Journal. Fall 1995.

[8] Brown, M. "How Can We Face the Challenge? Fifty Years at a Time". Chemical Waste Litigation Reporter. Descriptions of cases involving CERCLA. December 1994 Edition.

[9] City of Oak Ridge, Tennessee. Resolution concerning the Oak Ridge Reservation Site. April 5, 1999.

[10] Colorado Department of Public Health and the Environment. Roitman, H. "Institutional Control Guidance". Hazardous Materials and Waste Management Division. Review of "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls", written by the USEPA. May 10, 2000.

[11] Colorado Department of Public Health and Environment. Roitman, H. "Stewardship Issues: The States Perspective". Hazardous Materials and Waste Management Division.

[12] Colorado Department of Public Health and the Environment. Shwayder, P. Kornelly, I. "Joint Policy of the Colorado Statewide Defense Initiatives and the Colorado Department of Public Health and Environment Establishing Evaluation Guidelines and Review Procedures Pertaining to Deferral Requests". June 19, 1998.

[12a] Colorado General Assembly, Colorado Environmental Covenant Bill, SB01-145, Colorado Revised Statutes 25-15-317 through 327

[13] Colorado Water. Newsletter of the Water Center of Colorado State University. Fort Collins, Colorado. June 2000.

[14] Connell, J. Pickett, D. "Land Use Controls on BRAC Bases: A Special Report from ICMA's Base Reuse Consortium". International City/County Management Association. Superfund/Brownfields Research Institute.

[15] Costle, D. Bodde, D. Memorandum. Long-Term Stewardship Committee of the Environmental Management Advisory Board to the United States Department of Energy. January 21 1998.

[16] Coursen, D. "Institutional Controls at Superfund Sites". Environmental Law Reporter, News and Analysis. 23 ELR 10283.

[17] Coursen, D. "Use of Institutional Controls at Superfund Sites". Memorandum to the United States Environmental Protection Agency. July 27, 1992.

[18] Defense Environmental Response Task Force (DERTF). Executive Summary and Tables. Draft. June 22, 1998.

[19] Downing, P. W. "Institutional Controls for Groundwater Contamination". State Engineers Office. January 7, 1992.

[20] Edwards, A. "Long-Term Enforcement and Stewardship of Institutional Controls". BNA's Environmental Due Diligence Guide. No. 95. The Bureau of National Affairs. 2000.

[21] Edwards, A. "Raising the Stakes: EPA Region V's Challenge Regarding the Long-Term Viability and Enforceability of Institutional Controls at Brownfields Sites". Trends. May/June 2000.

[22] Edwards, T. "Survey on State Experience with Institutional Controls". Assistant Attorney General for the State of Texas. Working Draft. February 1999.

[23] Energy Communities Alliance and the Environmental Law Institute. Background on the Long-Term Stewardship and Institutional Controls Project". August 1999.

[24] Energy Communities Alliance and the Environmental Law Institute. Local Government Long-Term Stewardship Meeting Proceedings. Westminster, Colorado. April 8-9, 1999.

[25] Energy Communities Alliance and the Environmental Law Institute. Long-Term Stewardship/Institutional Controls Case Study. Questionnaire for Local Government Officials. September 1999.

[26] Energy Communities Alliance and the Environmental Law Institute. Background Paper on Long-Term Stewardship and Institutional Controls. Westminster, Colorado. April 8-9, 1999.

[27] Energy Communities Alliance and the International City/County Management Association. Kirshenberg, S. "Cleaning Up After the Cold War: Roles of Local Government in the Environmental Cleanup of Federal Facilities". Presentation at the National Association of Attorneys General Meeting. San Francisco, CA. June 1996.

[28] Energy Communities Alliance and the International City/County Management Association. "Cleaning Up After the Cold War: The Role of Local Governments in the Cleanup and Reuse of Federal Facilities". International City/County Management Association Special Report. 1996.

[29] Energy Communities Alliance Bulletin. "Los Alamos Acquires Several Properties from DOE". September 21, 1998.

[30] Energy Communities Alliance Bulletin. Volume 4. Issue 13. March 1999.

[31] Energy Communities Alliance. Kirshenberg, S. "Comments on Institutional Controls Manual and Land Use Controls". July 7, 1998.

[32] Energy Communities Alliance. Kirshenberg, S. "Update Concerning the Citizen's Monitoring and Technical Assessment Fund". Wednesday, October 6, 1999.

[33] Energy Communities Alliance. "Rocky Flats Environmental Technology Site". June 12, 2000.

[34] Environmental Law Institute. "Research Report: Institutional Controls Case Study: Grand Junction". 1999.

[35] Environmental Law Institute. "Research Report: Institutional Controls Case Study: Mound Plant". 1998.

[36] Environmental Law Institute. "Research Report: Institutional Controls in Use". September 1995.

[37] Environmental Law Institute. "Protecting Public Health at Superfund Sites: Can Institutional Controls Meet the Challenge?" Copyright 2000.

[38] Environmental Management Advisory Board Long-Term Stewardship Committee. Report and Recommendations. October 8, 1999.

[39] Fernald Citizens Task Force. "Recommendations on Remediation Levels, Waste Disposition, Priorities and Future Use". July 1995.

[40] FY2000 Defense Authorization Act Conference Report. Long-Term Stewardship Plan. Excerpt from the Congressional Record, August 5, 1999; page H7855.

[41] Gajilan, A. "History: We're Losing It". Newsweek. July 12, 1999.

[42] Gaspar, C. Van Burik, D. "Local Government Use of Institutional Controls at Contaminated Sites". ICMA's Brownfields/Superfund Series. International City/County Management Association. April 1998.

[43] GEI Consultants, Inc. Management Plan: Denver Radium Site, Operable Unit 7 - Denver Streets. Prepared for City and County of Denver Environmental Services. Project 96136. October 15, 1993.

[44] Geroux, B. "Munitions Hunt About to Start: Former Depot Site Abuts College Campus". Richmond Times-Dispatch. Area/State Section, pg. C-1. February 18, 1996.

[45] Goodman, S. "Future Land Use Policy and Lead-Based Paint". NAID Newsletter. July/August 1997.

[46] Green, J. "Institutional Controls At Closing Military Bases". National Association of Attorneys General Environment Series. Copyright 1997.

[47] Haggin, L. "Dangerous Chemicals Reported at Garage Site: NJ Transit Building on Old Landfill". (New Jersey) The Record. News Section, Pg. A01. December 3, 1995.

[48] Hanford Advisory Board. Reeves, M. "Institutional Controls". Letter to the EPA, DOE and the Washington State Dept. of Ecology. February 1, 1997.

[49] High Eagle, C. "Letter from the Nez Perce Tribe to Dr. Huntoon of the Department of Energy Concerning Long-Term Stewardship". STGWG Meeting. March 29, 2000.

[50] Holthaus, D. "Railroad Knew About Toxins Dump Site Seeps Near Mill Creek". Cincinnati Post. Metro Section, pg. 14A. December 6, 1995.

[51] Hurley, G. "Managing Construction Risks at Closing Military Bases". The Procurement Lawyer. Winter 1999.

[52] Hurley, G. "The Transfer and Reuse of Contaminated BRAC Property – The Myth of The CERCLA Covenant". The Federal Facilities Environmental Journal. Spring 1996.

[53] ICF Kaiser. "Managing Data for Long-Term Stewardship". Working Draft. March 1998.

[54] ICF Kaiser. "Summary of Department of Defense Long-Term Stewardship Issues". Prepared for the Department of Energy. December 1998.

[55] International City/County Management Association. Notes from the Meeting with the EPA Concerning Institutional Controls at Contaminated Properties. March 16, 1998.

[56] Kleinfelder, Inc. "Results of a Model for Improving Institutional Controls of Brownfields". Properties of City of Portland. Brownfields Initiative. "One Call for Brownfields" Pilot Project. Kleinfelder Project No. 60-5264-01-A01. Draft. January 5, 2000.

[57] Kratina, K. "Institutional Controls: A Means to an End at LUST Sites". New England Interstate Water Pollution Control Commission. Bulletin 28. February 1998.

[58] Lake County Overlay District. "Institutional Control Overlay (ICO) District". April 27, 2000.

[59] "Long Term Stewardship: How Long? – Half Lives of Radio Nuclides, Decay Products".

[60] "Long Term Stewardship: What Is It? What Should We Do About It?". Draft. April 26, 2000.

[61] "Looking Beyond Closure: The Stewardship Dialogue at Rocky Flats". Presentation, in the files of David Abelson.

[62] Lyons, C. Edge, R. Tarlton, S. Werner, J. "Protecting Ourselves from Our Nuclear Mess: Can the Backyard Neighbors Agree with DOE on Long-Term Stewardship?". Air and Waste Management Association, 93rd Annual Meeting. Salt Lake City, UT. June 18-22, 2000.

[63] Macy, J. "Guardians of Gaia". The Tides Foundation. Nuclear Guardianship Forum. Berkeley, California. November/December 1989.

[64] Malone, C. "Implications of Resources Management at the Nevada Test Site". Federal Facilities Environmental Journal. Spring 1998.

[65] Malone, J. "Paducah Plant's Neighbor Gets Municipal Water". The Courier Journal. Paducah, KY. October 23, 1999.

[66] Miller, D. "Implementing Institutional Controls in Colorado". Prepared for the Defense Environmental Response Task Force. Colorado Department of Law. February 3, 1999.

[67] Miller, D. Comments of Long-Term Stewardship Activities and Issues". Letter to Steven Livingstone of the US Department of Energy. State of Colorado Department of Law. January 4, 2000.

[68] MK-Ferguson and Jacobs Engineering Group. "Stewardship Plan for the Weldon Spring Site". Prepared for the US Department of Energy Oak Ridge Operations Office. Revision A. April 1999.

[69] National Academy Press. "Environmental Uncertainty in Risk-Based Methodologies".

[70] National Research Council. "Long-Term Institutional Management of U.S. Department of Energy Legacy Sites". August 7, 2000.

[71] Nuclear Guardianship Forum on the Responsible Care of Radioactive Materials. Issue 3. The Tides Foundation. Berkeley, California. Spring 1994.

[72] Oak Ridge Reservation End Use Working Group Stewardship Committee (EUWGSC). "Final Report of the Oak Ridge Reservation End Use Working Group". July 1998.

[73] Oak Ridge Reservation End Use Working Group Stewardship Committee (EUWGSC). "Stakeholder Report on Stewardship". Draft. June 10, 1998.

[74] Oak Ridge Reservation End Use Working Group Stewardship Committee (EUWGSC). "Stakeholder Report on Stewardship". July, 1998.

[75] Oak Ridge Reservation End Use Working Group Stewardship Committee (EUWGSC). "Stewardship Report". Draft. May 27, 1998.

[76] Oak Ridge Reservation End Use Working Group. Mulvenon, N. "'The Signs of Stewardship', A Case Study in Stewardship". April 12, 1998.

[77] Oak Ridge Reservation Local Oversight Committee. Gawarecki, S. "Land Use Controls at the DOE Oak Ridge Reservation, Tennessee". Presentation at the Western Stakeholders' Forum on Land Use Controls in Federal Facilities. February 10-12, 2000.

[78] Oak Ridge Reservation Local Oversight Committee, Inc. "Insights". Included are several leaflets explaining the budget, stewardship and views of the corporation. November 1998.

[79] Oak Ridge Reservation Stewardship Working Group (SWG). "The Oak Ridge Reservation: Stakeholder Report on Stewardship". Volume 2. December 1999.

[80] Oak Ridge Reservation Stewardship Working Group (SWG). Process Description. Draft. March 24, 1999.

[81] Office of the Governor of Colorado, Roy Romer. Executive Order D 013-98. "Evaluation of Requests for Transfer of Contaminated Federal Property". June 18, 1998.

[82] Page, N. Eddowes, M. Nixon, B. "Risk Management Issues in Site Stewardship, A Discussion Paper". Prepared for the United States Department of Energy - Center for Risk Excellence. AEA Technology plc. September 1998.

[83] Pendergrass, J. "Sustainable Redevelopment of Brownfields: Using Institutional Controls to Protect Public Health". ELR News and Analysis. 26 ELR 10109. March 1996.

[84] Pendergrass, J. "Use of Institutional Controls as Part of a Superfund Remedy: Lessons from Other Programs". ELR News and Analysis. 26 ELR 10109. March 1996.

[85] Peters, V. "Draft Institutional Controls: A Reference Manual". Review and Comment Memorandum to Stephen Hess and Sharon Frey of the USEPA. June 29, 1998.

[86] Pirie, jr., R. "DoN Environmental Policy Memorandum 95-02: Use of Land Use in Determining Cleanup Standards for BRAC Property". US Department of the Navy.

[87] Port of Benton. "Forty Years of Planning and Implementation for Hanford Site Reuse. March 31, 1999.

[88] Real Property Clearing House. "General Reference Guide to Real Property Policy". http://policyworks.gov/org/main/mp/library/policydocs/agpolicy.html

[89] Resources for the Future. "Creating a Successful Long-Term Stewardship Program for DOE Sites". Workshop Proceedings. April 16-17, 1998.

[90] Resources for the Future. Hersh, R. Probst, K. Wernstedt, K. Mazurek, J. "Linking Land Use and Superfund Cleanups: Uncharted Territory". Center for Risk Management. June 1997.

[91] Resources for the Future. "Linking Land Use to Superfund Cleanups Presents Challenges, RFF Report Finds". Washington, D.C. June 1997.

[92] Resources for the Future. "Long-Term Stewardship and Nuclear Weapons Complex: The Challenge Ahead". Washington, D.C. March 1998.

[93] Resources for the Future. "Long-Term Stewardship and the Nuclear Weapons Complex". Washington, D.C. February 1997.

[94] Resources for the Future. "Long-Term Stewardship at Contaminated Sites: Innovative Funding and Oversight Mechanisms". Center for Risk Management. Washington D.C. August 2000.

[95] Resources for the Future. Mazurek, J. Hersh, R. "Land Use and Remedy Selection: Experience from the Field – The Abex Site. Washington, D. C. July 1997.

[96] Resources for the Future. Probst, K. "Institutional Controls: The Next Frontier". Center for Risk Management Newsletter. Issue No. 15. Spring 1999.

[97] Resources for the Future. Probst, K. Lowe, A. "Cleaning Up the Nuclear Weapons Complex: Does Anybody Care?" Center for Risk Management. January 2000.

[98] Resources for the Future. Probst, K. McGovern, M. "Long-Term Stewardship and the Nuclear Weapons Complex: The Challenge Ahead". Center for Risk Management. Washington D.C. June 1998.

[99] Resources for the Future. Probst, K. "Long-Term Stewardship and the Nuclear Weapons Complex: The Challenge Abroad". Resources. Issue 131. Washington D.C. Spring 1998.

[100] Resources for the Future. "RFF Researchers Ask, 'Does Anybody Care About Cleaning Up the Nuclear Weapons Complex?'". Washington, D.C. January 1998.

[101] Resources for the Future. Second Annual RFF Workshop on Long-Term Stewardship. "Creating a Successful Long-Term Stewardship Program for Sites in the Nuclear Weapons Complex. Workshop Summary. April 16-17 1998.

[102] Resources for the Future. Wernstedt, K. Probst, K. "Land Use and Remedy Selection: Experience from the Field – The Industri-Plex Site". Washington, D.C. July 1997.

[103] Resources for the Future. Workshop on Long-Term Stewardship Proceedings. Washington, D.C. January 16-17, 1997.

[104] Reutzel, J. Burbridge, G. Smith, E. "A Primer on Local Government Regulation of Land Use and Development". The Rocky Mountain Land Use Institute: Seventh Annual Conference. Denver, Colorado. March 13, 1998.

[105] Rocky Flats Citizens Advisory Board (CAB). Annual Report 1999.

[106] Rocky Flats Industrial Area Transition Task Force. "From Swords to Plowshares: A Plan for the Reuse of the Industrial Area of the Rocky Flats Environmental Technology Site". Presented to the Rocky Flats Local Impacts Initiative for the US Department of Energy, Kaiser-Hill and the People of Colorado. Draft. August 13, 1998.

[107] Rocky Flats Stewardship Dialogue Planing Group. "Beyond Closure: Stewardship at Rocky Flats". April 1999.

[108] Rocky Flats Summit. "What is Ethical Stewardship?" January 20, 1996.

[109] Rocky Mountain Peace Center. "A Citizen's Guide to Rocky Flats: Colorado's Nuclear Bomb Factory". June 1992.

[110] Sand Creek Industrial Superfund Site. Operable Unit 4 (Site-wide Groundwater Operable Unit), Record of Decision. April 1994.

[111] Schilling, J. Gaspar, C. Mishkovsk, N. "Beyond Fences: Brownfields and the Challenges of Land Use Controls". International City/County Management Association. Summer 2000.

[112] Shrader – Frechette, K. "Discussion Papers – Ethical Dilemmas and Radioactive Waste: A Survey of the Issues". Environmental Ethics. Vol. 13, No. 4. Center for Environmental Philosophy, the University of North Texas. Denton, Texas. Winter 1991.

[113] Siegel, L. "A Stakeholders Guide to the Cleanup of Federal Facilities". Center for Public Environmental Oversight. San Francisco. Copyright 1998.

[114] Sikkema, E. "The Utilization of Institutional Controls at Superfund Sites in Region VIII of the USEPA". Prepared for the Hazardous Waste Management Division, USEPA Division VIII. September 24, 1991.

[115] Smith, G. "Evolution of Disposal Cell Cover Design Used for Uranium Mill Tailings Long-Term Containment". Roy F. Weston, Inc. Report for the US Department of Energy Grand Junction Office. March 1999.

[116] SSAB National Conference on Stewardship. Information Packet. Stewardship Working Group. November 1999.

[117] State and Tribal Government Working Group. "Closure for the Seventh Generation". A Report from the Stewardship Committee. National Conference of State Legislatures. February 1999.

[118] State of Arizona. "Soil Remediation Standards, Restrictions on Property Use". http://www.azleg.state.az.us/ars/49/152.html

[119] State of Arkansas. Policy on Institutional Controls. http://www.arkleg.state.ar.us

[120] State of California Supreme Court. California Coastal Commission v. Granite Rock Company. March 24, 1987. Concerning mining permit requirements. West Group. 1999.

[121] State of Colorado Department of Health, Waste Water Control Division, the Colorado Department of Natural Resources and the Office of the State Engineer. "Memorandum of Agreement for the Implementation of the SB 181 Amendments to the Colorado Water Quality Control Act". August 30, 1990.

[122] State of Colorado Department of Natural Resources, Division of Water Resources. "Implementation of Subsection 25-8-202(7), C.R.S. March 30, 1992.

[123] State of Colorado Revised Statutes. "Telecommunications Research Facilities of the United States Protection Act of 1969". Volume 12A, Part 6. 1986 Replacement Volume with 1995 Cumulative Supplement. Government IIIA. 1986.

[124] State of Indiana. "Indiana Code, Title 13". http://www.state.in.us/legislative/ic/code

[125] State of Massachusetts. Chapter 21E: Section 6. "Department Requirements for Prevention and Control of Releasing Restrictions on Property, Notice Liability". http://www.state.ma.us/legis/laws/mg1/21E-6.htm

[126] State of Massachusetts. 310 CMR. Department of Environmental Regulation. Part40.1070-40.1099.

[127] State of Michigan. "Transfer of Interest in Real Property; Notice; Certification ; Disclosure of Restrictions". http://www.michiganlegislature.org

[128] State of Minnesota. "Chapter 115B: Environmental Response and Liability".

[129] State of Minnesota. "Chapter 84C: Conservation Easements".

[130] State of New Hampshire. "Title 10: Public Health, Chapter 147F – Brownfields Program". http://199.92.250.14/rsa/10/147-F-15.HTML

[131] State of New Jersey. "Senate Committee Substitute for Senate, No. 1070". March 15, 1993.

[132] State of Ohio. "Ohio Revised Code, Title 37". http://orc.avv.com/title-37

[133] State of Oklahoma. "Title 27A-2-15". http://oklegal.onenet.net

[134] State of Tennessee Department of Environment and Conservation. Division of Solid Waste Management. Consent Order. November 1999.

[135] State of Tennessee, Bear Creek Valley Operable Unit. CERCLA Record of Decision. Uranium Burial Grounds. Tennessee Guidance Policy. Includes Letters and Memoranda Concerning the Establishment of an Environmental Cleanup Trust Fund. September 1, 1997.

[136] Stewardship Discussion Group Meeting Proceedings. RFLII. Thursday, October 8, 1998.

[137] Superfund Report. Letter to DoD on Institutional Control Enforcement from the USEPA. pg. 22-27. August 5, 1998.

[138] Urban Land Institute. "Brownfields Redevelopment". InfoPacket No. 388. Washington, D.C. 1996.

[138a] U.S. Congress, Rocky Flats National Wildlife Refuge Act December 28, 2001.

[139] US Court of Appeals, Tenth Circuit. "Appeal from the United States District Court for the District of Colorado, D.C. No. 94-D-2004". Concerns the Denver Radium Superfund Site.

[140] US Department of Defense. "A Guide to Establishing Institutional Controls at Closing Military Installations". February 1998.

[141] US Department of Defense. "DoD Guidance on the Environmental Review Process Required to Obtain the Finding of Suitability for Use of Early Transfer Authority for Property Not on the National Priorities List as Provided by CERCLA Section 120(h)(3)(C)". April, 1998.

[142] US Department of Defense. "DoD Policy on Responsibility for Additional Environmental Cleanup after Transfer of Real Property". July 25, 1997.

[143] US Department of Defense. "Institutional Controls: What they are and how they are used". Spring 1999.

[144] US Department of Energy Advisory Board. "Recommendations on Institutional Controls". January 3, 2000.

[145] US Department of Energy Environmental Management Advisory Board. Report and Recommendations of the Environmental Management Advisory Board Long-Term Stewardship Committee. October 8, 1998.

[146] US Department of Energy Grand Junction Office. Jacobsen, C. Jones, C. Plessinger, M. Edge, R. Virgona, J. "Long-Term Care at DOE Disposal Facilities". March 1998.

[147] US Department of Energy Grand Junction Office. Jacobsen, C. Jones, C. Plessinger, M. Edge, R. "Lessons Learned: Monitoring and Maintenance Experience at Completed Uranium Mill Tailings Sites, United States". March 1999.

[148] US Department of Energy Grand Junction Office. "Long-Term Surveillance and Monitoring Program Plan. June 1999.

[149] US Department of Energy Grand Junction Office. "Long-Term Surveillance and Monitoring Program, 1998 Report". March 1999.

[150] US Department of Energy Grand Junction Office. "Long-Term Surveillance and Monitoring Program, 1999 Report". March 2000.

[151] US Department of Energy Grand Junction Office. Proceedings from the Long-Term Stewardship (LTS) Workshop. June 2-3 1998. CONF-980652.

[152] US Department of Energy Grand Junction Office. Proceedings from the Long-Term Stewardship (LTS) Workshop. August 30-September 2, 1999.

[153] US Department of Energy Grand Junction Office. Proceedings from the Long-Term Stewardship (LTS) Workshop. August 7-9, 2000.

[154] US Department of Energy Office of Environmental Management. "From Cleanup to Stewardship: A Companion Report to Accelerating Cleanup: Paths to Closure." October 1999.

[155] US Department of Energy Office of Environmental Management. Jacobs EM Team. Land Use Control Assurance Plan for the Paducah Gaseous Diffusion Plant, Paducah, Kentucky". Prepared for the April 1999.

[156] US Department of Energy Office of Environmental Management. Livingstone, S. "After Completing Cleanup: Long-Term Stewardship". Presentation to Resources for the Future. April 17, 1998.

[157] US Department of Energy Office of Environmental Management. Livingstone, S. "DOE Headquarters' Progress on Long-Term Stewardship". Presentation to the State and Tribal Government Working Group, Idaho Falls, Idaho. October 20, 1999.

[158] US Department of Energy Office of Environmental Management. Livingstone, S. "Stewardship Data System". June 1997.

[159] US Department of Energy Office of Environmental Management. "Long Term Stewardship Resource Book, A Compilation of DOE-Related Research Projects, Reports and Workshops". Office of Policy, Planning and Budget. Draft. July 1998.

[160] US Department of Energy Office of Environmental Management. "Moving from Cleanup to Stewardship". Draft. September 17, 1997.

[161] US Department of Energy Office of Environmental Management, "Planning for the Future, An Overview of Future Use Plans at Department of Energy Sites". October 7, 1998.

[162] US Department of Energy Office of Environmental Management. Werner, J. "After Completing Cleanup: Long Term Stewardship". Presentation to Energy Communities Alliance. March 5, 1998.

[163] US Department of Energy Office of Environmental Management. Werner, J. "DOE's Long-Term Stewardship Activities". Presentation to Energy Communities Alliance and the Environmental Law Institute Local Government Long-Term Stewardship Meeting. April 9, 1999.

[164] US Department of Energy Office of Environmental Management. Werner, J. "Long-Term Stewardship at DOE Sites". Presentation to the National Association of Attorney's General. December 10, 1998.

[165] US Department of Energy Office of Environmental Management. Werner, J. "Long-Term Stewardship". Presentation at the Energy Communities Alliance Fall Conference. Richland, Washington. September 16, 1999.

[166] US Department of Energy Office of Environmental Management. Werner, J. "Long-Term Stewardship". Presentation at the National Governor's Association Task Force Meeting. Oak Ridge, Tennessee. September 16, 1999.

[167] US Department of Energy Office of Environmental Management. Werner, J. "Primer on Long-Term Stewardship". Presentation to Energy Communities Alliance and the Environmental Law Institute Local Government Long-Term Stewardship Meeting. April 8, 1999.

[168] US Department of Energy Office of Environmental Management. Werner, J. "Resource Packet on DOE Issues". Presentation to the Energy Community Alliance. March 4, 1999.

[169] US Department of Energy Office of Environmental Management. Werner, J. Barainca. "Science and Technology Needs for Long-Term Stewardship". Memorandum for Distribution. December 22, 1999.

[170] US Department of Energy Office of Inspector General. "Audit Report: Security Overtime at the Oak Ridge Operations Office". ER-B-00-02. June 2000.

[171] US Department of Energy Office of Inspector General. "Land Conveyance and Transfer at Los Alamos National Laboratory". IG-0469. April 2000.

[172] US Department of Energy Ohio Field Office. "Guiding Principles for Long-Term Stewardship". Miamisburg, Ohio. March 27, 2000.

[173] US Department of Energy Rocky Flats Field Office. "Corrective Action Decision / Record of Decision for Operable Unit 3, The Offsite Areas of Rocky Flats Environmental Technology Site. Golden, Colorado. April 1997.

[174] US Department of Energy Rocky Flats Field Office. "Future Use Stakeholder Involvement Process". 1997.

[175] US Department of Energy Rocky Flats Field Office. "Stewardship Cost Estimate". April 5, 1999.

[176] US Department of Energy. Donaldson, D. Row, C. "Stewardship Cost Estimate". April 14, 1999.

[177] US Department of Energy. Pacific Northwest National Laboratory. "Risk Based Requirements for Long-Term Stewardship: A Proof of Principle Analysis of an Analytic Method Tested on Selected Hanford Locations". November 1998.

[178] US Department of Energy. "Resourceful Reuse: A Guide to Planning Future Uses of Department of Energy Sites". Program and Real Property Managers. May 1996.

[179] US Department of Energy. "Sale and Purchase Contract for the Pinellas Plant, Florida". March 7, 1995.

[180] US Department of Energy. "Sales Contract Between the US DOE and the Miamisburg Mound Community Improvement Corporation". January 23, 1998.

[181] US Department of Energy. Grand Junction Office Perspective. "Long-Term Stewardship of Waste Disposal Sites". Volume 3. July 1998.

[182] US Department of Energy. Long Term Stewardship Workshop. Conference Notes. Grand Junction, Colorado. August 30 – September 2 1999.

[183] US Department of Energy. "National Study on Long-Term Stewardship Activities and Issues". Vol. 64, Federal Register, Page 54279. Wednesday, October 6, 1999.

[184] US Environmental Protection Agency, Region VIII and OERR Superfund Staff. Response Decision Forum Proceedings. Denver, Colorado. December 4, 1996.

[185] US Environmental Protection Agency. Abernathy, A. "Site Security Issues".

[186] US Environmental Protection Agency. Davis, T. "Ensuring the Security of Waste on Site: The Problem of Institutional Controls". Superfund Section, Waste Policy Branch, Office of Policy, Planning and Evaluation. August 1994.

[187] US Environmental Protection Agency. "Guidance on the Transfer of Federal Property by Deed Before All Necessary Remedial Action Has Been Taken Pursuant to CERCLA Section 120(h)(3) – (Early Transfer Authority Guidance)".

[188] US Environmental Protection Agency. "Guidance on Use of Institutional Controls at Superfund Sites". Draft. June 1991.

[189] US Environmental Protection Agency. Laws, E. "Land Use in the CERCLA Remedy Selection Process". May 25, 1995.

[190] US Environmental Protection Agency. "Institutional Controls and Transfer of Real Property Under CERCLA Section 120(h)(2)(A), (B) or (C)". Federal Facilities Restoration and Reuse Office. Interim Final Guidance. January 2000.

[191] US Environmental Protection Agency. "Institutional Controls: A Reference Manual". Draft. March 1998.

[192] US Environmental Protection Agency. "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups". Office of Solid Waste and Emergency Response. Draft. March, 2000.

[193] US Environmental Protection Agency. Johnston, J. "Assuring Land Use Controls at Federal Facilities". Federal Facilities Branch. April 21, 1998.

[194] US Environmental Protection Agency. Lowry Landfill Superfund Site Administrative Order for RD/RA. EPA Docket No. CERCLA VIII-95-05. November 1994.

[195] US Environmental Protection Agency. Woolford, J. "Transmittal of Interim Final Guidance: Institutional Controls and Transfer of Real Property under CERCLA Section 120(h)(3)(A)(B) or (C). January 6, 2000.

[196] US Fish and Wildlife Service, Department of the Interior. "Discover a New Refuge". Rocky Mountain Arsenal National Wildlife Refuge. March 1996.

[197] US General Services Administration, Office of Governmentwide Policy. "General Reference Guide for Real Property Policy". April 1998.

[198] US Nuclear Regulatory Commission (NRC). Office of Nuclear Regulatory Research. "Regulatory Guide: Demonstrating Compliance with Radiological Criteria for Decommissioning. License Termination under Restricted Conditions". Section C.3. Working Paper. June 1998.

[199] Vogel, S. "Search to Resume Near AU for WWI Chemicals". The Washington Post. Metro Section, p. C01. January 24, 1999.

[200] Walker, J. Liebendorfer, P. "Long-Term Stewardship at the Nevada Test Site". Nevada Division of Environmental Protection. Summer 1998.

[201] Waste Management 2000 Symposium. Long-Term Stewardship Workshop: Real Issues – Real Solutions. Tucson Arizona. February 28, 2000.

[202] Waugh, W. "Monitoring the Long-Term Performance of Uranium Mill Tailings Covers". Roy F. Weston, Inc. Grand Junction. March 1999.

[203] Wyeth, G. "Land Use and Cleanups: Beyond the Rhetoric". Environmental Law Report. 26 ELR 10358. July 1996.

[204] Zornberg, J. Christopher, B. The Handbook of Groundwater Engineering. Chapter 27, "Geosynthetics". Jacques W. Delleur, Editor. CRC Press. Washington D.C. 1999.

New sources added since last report, dated March 2001:

[205] US Department of Energy Office of Environmental Management. "Long-Term Stewardship Study" Draft for Public Comment. October 24, 2000.

[206] Energy Communities Alliance. Minutes from the Role of Local Government Long-Term Stewardship Roundtable. Denver. August 2-4, 2000.

[207] US Environmental Protection Agency. "Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups". Office of Solid Waste and Emergency Response. September, 2000.

[208] US Environmental Protection Agency. "Comprehensive Five-Year Review Guidance". June 2001.

[209] US Department of Energy Department of Environmental Management. Carolyn L. Huntoon. "Memorandum for the Deputy Secretary: Long-Term Environmental Stewardship Transition". October, 2000.

[210] US Department of Energy. "Long-Term Stewardship Mission: Strategic Plan". November 2000.

[211] US Department of Energy Office of Environmental Policy and Guidance. "Institutional Controls in RCRA and CERCLA: Response Actions". August 2000.

[212] Environmental Law Institute. "The Role of Local Governments in Long-Term Stewardship at DOE Facilities". 2000.

[213] Resources for the Future. Bauer, C. Probst, K. "Long Term Stewardship of Contaminated Sites: Trust Funds as Mechanisms for Financing and Oversight". December 2000.

[214] Rocky Flats Stewardship Working Group. "Hand-in-Hand: Stewardship and Cleanup". 2001.

Web Sources:

DOE Long Term Stewardship - http://www.em.doe.gov/lts
EPA Federal Facilities Restoration and Reuse Office - http://www.epa.gov/swerffrr
Landtracker Site (Topographical Maps) - http://www.landtracker.com
National Environmental Training Office - http://www.em.doe.gov/neto
Resources for the Future - http://www.rff.org
Oak Ridge End Use Working Group - http://www.oakridge.doe.gov/em/ssab/pubs.htm
Environmental Law Institute - http://www.eli.org/research.htm
Sandia Cooperative Monitoring Center - http://www.cmc.sandia.gov
Longnow Corporation - http://www.longnow.org
Federal Emergency Management Agency - http://www.FEMA.gov
DOE Grand Junction Office - http://www.doegjpo.com/programs/final
LandTrek (Tools for transfer and reuse of brownfields) - http://www2.doegjpo.com
Vistacheck (Environmental Risk Management Tool) - http://www.vistacheck.com
U.S. Fish and Wildlife Service - http://www.fws.gov/